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Glossary

Ambition North Wales (ANW): A regional partnership promoting economic growth, innovation, and infrastructure development in North Wales.

Department for Business, Energy & Industrial Strategy (BEIS): A former UK government department responsible for business, energy, and industrial policy, now merged into the Department for Energy Security and Net Zero (DESNZ).

British Industrial Competitiveness Scheme (BICS): A UK government initiative aimed at reducing energy costs for energy-intensive industries to improve competitiveness.

Capital Expenditure (CAPEX): Costs associated with building or acquiring physical assets for a project, such as infrastructure, equipment, or facilities.

Carbon Border Adjustment Mechanism (CBAM): CBAM is an environmental policy instrument designed to prevent carbon leakage by imposing a carbon price on imports of certain goods, ensuring a level playing field between UK and non-UK producers.

Carbon Capture, Utilisation and Storage (CCUS): CCUS refers to a suite of technologies that capture carbon dioxide emissions from industrial processes or directly from the atmosphere, and either reuse it or store it underground to prevent its release into the atmosphere.

Contract for Difference (CfD): A CfD is a financial mechanism where a public body pays the difference between the market price and a pre-agreed ‘strike price’ to support low-carbon electricity generation.

Control of Major Accident Hazards (COMAH): UK regulations designed to prevent and mitigate major accidents involving dangerous substances at industrial sites.

Consumer Price Index (CPI): A measure of inflation that measures the change in the price of a basket of goods and services consumed by households in the UK.

Department for Energy Security and Net Zero (DESNZ): The UK government department responsible for delivering energy security and driving the transition to net zero emissions.

Development Expenditure (DEVEX): Costs incurred during the early stages of a project, such as feasibility studies, design, permitting, and planning, before construction begins.

Energy Innovation Programme (EIP): A UK government programme funding research and development in low-carbon energy technologies.

Emissions Trading Scheme (ETS): A cap-and-trade system that sets a limit on total greenhouse gas emissions and allows trading of emission allowances to incentivise reductions in emissions.

Front-End Engineering Design (FEED): The initial design phase of a project that defines technical requirements, scope, and cost estimates before full-scale development.

Great British Energy (GBE): A proposed publicly owned energy company in the UK aimed at investing in clean energy and supporting national energy security.

Gas Shipper Obligation (GSO): A proposed UK levy on gas shippers to fund long-term support for low-carbon hydrogen production.

Gross Value Added (GVA): A measure of the value of goods and services produced in an area, industry, or sector of the economy.

Hydrogen Allocation Round (HAR): Competitive processes run by the UK government to allocate funding or contracts for low-carbon hydrogen production projects.

Hydrogen Business Model (HBM): A UK government framework to support the commercial deployment of low-carbon hydrogen production.

Hydrogen Production Business Model (HPBM): A UK government framework designed to support the commercial deployment of low-carbon hydrogen production through revenue support mechanisms.

Low Carbon Hydrogen Supply (HS): A UK innovation programme supporting the development of low-carbon hydrogen production and supply chains.

Hydrogen Skills Alliance (HSA): A UK innovation programme supporting the development of low-carbon hydrogen production and supply chains.

Hydrogen Storage Business Model (HSBM): A proposed UK framework to incentivise investment in hydrogen storage infrastructure, ensuring system flexibility and energy security.

Health and Safety Executive (HSE): The UK's national regulator for workplace health and safety, including oversight of hazardous materials.

Hydrogen Transport Business Model (HTBM): The UK's planned support mechanism for developing hydrogen transport infrastructure, such as pipelines and compression facilities.

Industrial Energy Transformation Fund (IETF): A UKRI-funded programme supporting industrial clusters to reduce carbon emissions through innovation and infrastructure.

Industrial Fuel Switching (IFS): A UK programme supporting the transition of industrial processes from fossil fuels to low-carbon alternatives.

Local Area Energy Plan (LAEP): Strategic plans developed by local authorities to guide the decarbonisation of energy systems at the local level.

Low Carbon Contracts Company (LCCC): A UK government-owned company that was officially designated as the counterparty for hydrogen production revenue support contracts under the Energy Act 2023.

Low Carbon Hydrogen Agreement (LCHA): A contractual agreement under the UK's HPBM, between a hydrogen producer and the LCCC, that provides revenue support to hydrogen producers based on agreed terms.

Low Carbon Hydrogen Standard (LCHS): Sets the maximum greenhouse gas emissions allowed per unit of hydrogen produced for it to be considered 'low carbon' in the UK.

Local Industrial Decarbonisation Plan (LIDP): UK-funded plans enabling smaller industrial areas to prepare for low-carbon technology deployment.

National Energy System Operator (NESO): A newly established body responsible for overseeing the planning and operation of the UK's energy system, including electricity and gas networks, to support the transition to net zero.

North East Wales Industrial Decarbonisation (NEWID): A regional industrial cluster in North Wales focused on transitioning to low-carbon technologies.

Net Zero Hydrogen Fund (NZHF): A UK government fund providing capital support for low-carbon hydrogen production projects.

Net Zero Industry Wales (NZIW): An independent organisation supporting Welsh industry in achieving net zero emissions through collaboration and innovation.

Office for National Statistics (ONS): The UK's largest independent producer of official statistics and the recognised national statistical institute.

Power Purchase Agreements (PPAs): Contracts between electricity producers and buyers that define terms for the sale of electricity, often used to support renewable energy projects.

Regulated Asset Base (RAB): A RAB model is used to incentivise private investment into public projects by providing a secure payback and return on investment for developers. Within this mechanism, energy companies manage the infrastructure project, taking ownership of the assets and operating costs. In return, they can raise revenue, often through customer bills, and can also be offered government subsidies.

Risk-Taking Intermediaries (RTIs): RTIs are entities or institutions that assume financial or operational risk to facilitate investment in early-stage or uncertain technologies, often playing a catalytic role in energy innovation and deployment.

South Wales Industrial Cluster (SWIC): A major industrial cluster in South Wales working to decarbonise industry through collaboration and innovation.

Welsh Industrial Hydrogen Research (WIHR): This project, undertaken by Arup on appointment by Welsh Government.

Wales & West Utilities (WWU): The gas distribution network operator for Wales and the South West of England, responsible for maintaining and upgrading gas infrastructure.

Executive Summary

Introduction and purpose

The Welsh Industrial Hydrogen Research project (WIHR) aimed to identify, develop and build an understanding of how fuel switching to hydrogen could be commercially and economically viable for the Welsh industrial sector. Arup was commissioned to undertake this research and to collaborate with stakeholders to produce recommended actions for Government.

This report presents the background to this research, the methodology used, the findings, and recommended actions for Welsh and UK Government.

Background and context

Wales has a proud industrial heritage which has shaped the economy, communities and the political landscape since the industrial revolution. Industry in Wales currently employs around 150,000 people and contributed around 18% of the Welsh Gross Value Added in 2023. However, industry in Wales accounts for 28% of the nation's total emissions. Achieving net zero greenhouse gas emissions by 2050 is a legally binding requirement for Wales and the UK and therefore it is essential that Welsh industry can decarbonise. Without this, Wales risks significant deindustrialisation and associated job losses, as well as a missed positive contribution to the Welsh economy and communities.

Hydrogen provides an attractive decarbonisation option for hard-to-decarbonise industry that requires high grade heat and cannot be electrified. It is now timely to review the progress towards industrial decarbonisation using hydrogen in Wales.

Findings

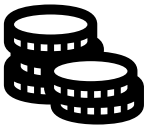
Project and infrastructure development

Wales has all the component parts required for the production and use of hydrogen to decarbonise industry in both North and South Wales with the right support.

Significant work is already underway towards decarbonising industry using hydrogen in Wales and this provides an excellent springboard from which to build. It is already home to key low-carbon hydrogen projects;

- Wales currently has more than 170 MW of planned green hydrogen production as well potential for up to 1 GW of hydrogen production in the Celtic Sea as part of the Dolphyn Hydrogen project.
- Wales & West Utilities is developing two hydrogen pipeline projects, HyLine Cymru and HyLine Gogledd, which will require collaboration with HyNet in North West England (both hydrogen and carbon capture and storage pipelines) and Project Union across Great Britain.
- There is ongoing collaboration within industry in Wales through the South Wales Industrial Cluster (SWIC) and North East Wales Industrial Decarbonisation (NEWID) cluster.

However, evidence suggests that there is greater scope for Wales to access a greater share of UK Government support. For example, only 3 out 27 Hydrogen Allocation Round (HAR) 2 shortlisted projects were in Wales, and Wales received only 15 projects of 160 projects as part of the Industrial Energy Transformation Fund.



Business models and funding

Lack of offtake model flexibility in the current hydrogen production business models and lack of hydrogen fuel switching support make it difficult to secure long-term offtake commitment.

UK hydrogen business models are welcomed as a form of support for hydrogen project development. However, many stakeholders stated that clarity and certainty around timelines, eligibility criteria, assessment processes, and how the various business models will integrate is essential to ongoing industry confidence in these schemes. Industry stakeholders noted it is timely to revisit the offtaker eligibility and commitments and consider amendments to best support the emerging hydrogen market. Given the early stages of many of these business models, Welsh Government should continue to influence their development to meet the needs of the Welsh value chain. This will require a receptive UK Government that is willing to take account of Wales' distinct industrial needs.

A review of public funding options in the UK and Wales also found a lack of incentive for industrial fuel switching following the closure of key UK schemes, such as the Industrial Energy Transformation Fund (IETF). Potential hydrogen users in Wales are reluctant to undertake the costly and risky work necessary to investigate fuel switching to hydrogen without incentives. Without offtakers, hydrogen developers are unable to make their projects commercially viable. If the funding support vacuum to investigate fuel switching is addressed more businesses may be inclined to consider switching.

Funding and timing certainty for HyLine Cymru and HyLine Gogledd to progress through FEED and into construction is crucial to Wales, without which, both the NEWID and SWIC clusters risk deindustrialisation.

Without hydrogen, significant industry in the NEWID and SWIC clusters will be unable to decarbonise. Both the NEWID and SWIC clusters are reliant on the WWU planned hydrogen pipelines HyLine Gogledd and HyLine Cymru respectively, to deliver the volumes of hydrogen required to achieve decarbonisation. Without these pipelines being developed, Wales risks deindustrialisation.

Ofgem recently did not approve WWU's request to fund the FEED study for HyLine Cymru and referred WWU to the upcoming HTBM. Stakeholders lack certainty on the timing and structure of the HTBM, and do not believe it will fund the necessary costly FEED study. It is therefore unclear how the HyLine projects will be able to proceed with FEED to secure the future of industry in Wales.

Shared narrative and strategy

Wales needs a clear narrative and strategy for hydrogen across the value chain and its use in industrial decarbonisation to promote growth, investment and skills.

Wales lacks a cohesive narrative for hydrogen in Wales. There is no national hydrogen strategy with clear ambitions, targets and timelines for hydrogen production, storage, distribution, use and skills. Stakeholders, including representatives from hydrogen producers, academia and industry bodies, highlighted that without this, Wales is at risk of not being able to articulate the ambition and needs of Welsh industry, as well as the potential for Wales to significantly contribute to the ambitions of UK Government.

Industry stakeholders emphasised that there is also a need for this narrative to flow through into other strategies and delivery. Academic stakeholders highlighted that there is

an opportunity for Wales to strategically plan for the demand on other resources such as water.

Policy, regulation and consenting

Hydrogen projects in Wales are not being delivered quickly due to a range of limiting factors including delays to securing grid connections and lengthy planning and consenting processes.

NESO has an ongoing programme to address grid connections. Through this, it will be critical for Welsh hydrogen projects to be prioritised to be able to deliver on the net zero ambitions of Wales. Stakeholders, including hydrogen producers and industry, highlighted that delays in and the cost of accessing the grid for large scale projects was a major reason as to why they are not being delivered.

The separation of the UK and EU Emissions Trading Schemes (ETS) means industry may be exposed to Carbon Border Adjustment Mechanism (CBAM) payments, reducing their competitiveness. In addition, the smaller, more volatile nature of the standalone UK carbon market creates uncertainty for businesses, making investment in decarbonisation technologies less commercially attractive.

Collaboration and engagement

Welsh industrial clusters need connections to infrastructure in England to enable access to the volumes of hydrogen required to decarbonise industry. Collaboration and engagement are critical to enable this.

Without the ability to connect to the HyLine Gogledd pipeline in North West England, the NEWID cluster has identified that it may struggle to secure or store the hydrogen required to decarbonise its industry. Cross-border collaboration and co-operation which can enable NEWID to access hydrogen supply via HyNet is critical to the future of NEWID industry. The SWIC is less reliant on cross-border resources but may still benefit from exploring opportunities to collaborate across the border with England, including a connection to Project Union.

Proposed actions

Using the research and working in close collaboration with key stakeholders, we identified actions to respond to these findings and unlock industrial decarbonisation with hydrogen in Wales. The highest priority actions are shown below alongside proposed action owners:

Theme	Action	Owner
	Introduce flexibility for offtakers under the HPBM.	UK Gov
	Incentivise industrial fuel switching through targeted support mechanisms.	UK Gov
	Align the HPBM with CfD-backed renewable generators.	UK Gov
	Provide greater certainty to industry throughout the HAR3 and HAR4 processes, and on HSBM and HTBM.	UK Gov
	Work with UK Government and WWU to secure funding for the development of Wales-based HyLine projects.	Welsh Gov

Theme	Action	Owner
	Develop a hydrogen strategy and roadmap for Wales.	Welsh Gov
	Engage with NESO to influence and accelerate grid reform.	Welsh Gov
	Support NEWID to collaborate and co-operate with the North West Cluster to secure a connection to HyNet.	Welsh Gov

1. Introduction and purpose

1.1 Project overview

This project was commissioned to provide a robust evidence base that informs public sector policy and investment decisions for hydrogen as a fuel for industrial decarbonisation in Wales, and to deliver actionable insights and a clear roadmap for Welsh Government and partners. It consolidates evidence from the literature, stakeholder engagement, and market analysis to guide policy discussions, including dialogue between Welsh Government and UK Government on industrial decarbonisation.

The research explored the technical, economic and wider challenges associated with fuel switching to hydrogen within Welsh industry. The report details the opportunities and barriers highlighted through the literature and stakeholder engagement, providing an evidence-based understanding of the factors influencing large-scale hydrogen deployment in Wales.

Specifically, the objectives of the project were to:

- Undertake a review of published evidence and literature on industrial decarbonisation and hydrogen to understand the state of play in the UK and Wales.
- Work with stakeholders (industry, hydrogen producers, academia and trade bodies) and Welsh Government to identify the technical, economic and commercial challenges and opportunities for industrial decarbonisation using hydrogen in Wales.
- Create a roadmap with clear timeframes and credible actions for the Welsh Government to develop the hydrogen economy in Wales.
- Consolidate the evidence and findings from the stakeholder engagement in a report for Welsh Government.

1.2 Report structure

This report presents a comprehensive overview of the Welsh Industrial Hydrogen Research Project, detailing its context, methodology, findings, and proposed actions. The structure of the report is designed to guide the reader through the journey of the research, from its origins to its practical implications:

Chapter 2: Background and Context

This chapter sets the scene by exploring Wales's rich industrial heritage and the potential role of hydrogen in supporting industrial decarbonisation. It provides the foundational context for understanding the relevance and urgency of the project.

Chapter 3: Methodology and Analysis

Here, the report outlines the research approach, including the methods and analytical steps undertaken. This chapter explains how the evidence was gathered and interpreted, forming the basis for the findings and actions.

Chapter 4: Findings

This chapter presents the main and supporting findings of the research. It draws on insights from the literature review and incorporates perspectives from stakeholders gathered through engagement, highlighting both qualitative and quantitative evidence.

Chapter 5: Action Plan

Developed collaboratively with stakeholders through interactive workshops, this chapter proposes a set of targeted actions to address the findings. These actions aim to support the adoption of hydrogen in Wales's industrial sectors.

Chapter 6: Routemap

The final chapter translates the action plan into a timeline, aligning proposed interventions with existing and planned activities. It offers a strategic routemap for Wales to advance industrial decarbonisation through hydrogen.

2. Background and context

2.1 Industry in Wales

Wales has a deep-rooted industrial heritage and culture, with Welsh coal powering the first industrial revolution. This abundance of a competitively priced, high-quality energy source attracted energy intensive industry to both North and South Wales.

To date, this industrial footprint still largely remains with industry[1] clustered around the South Wales coast and North East Wales. Wales hosts energy-intensive industries across multiple sectors including, but not limited to cement, steel, chemicals, glass and ceramics, paper, food and drink[2].

These industries are rooted into the Welsh culture and economy, with industry in South Wales employing 113,000 people and contributing £6 billion in Gross Value Added. South Wales hosts more jobs more than any of the five other UK industrial clusters identified in the Industrial Decarbonisation Challenge[3]. Likewise, industry in North East Wales employs 34,000 people[4].

The UK's industrial sector accounts for 14% (57 MtCO2e, 2022) of all UK greenhouse gas emissions[5]. More than two thirds of this comes from a small number of energy intensive industries which are difficult to decarbonise. Almost half of these emissions can be attributed to clustered industry in the UK which are geographically proximal in industrial heartlands, and which could benefit from shared infrastructure and industrial symbiosis.

Industry in Wales accounted for 10,100 ktCO2e/yr of emissions in 2022, representing 28% of the total emissions in Wales (36,400 ktCO2e/yr, 2022)[6]. This is double the industrial

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[1] For the purposes of this project, the term 'industry' refers to businesses and organisations involved in energy-intensive processes such as manufacturing, refining, coke production and mining (DESNZ, 2021). This includes chemical, paper and pulp, glass, ceramics, cement and refining. Power generation or transport are not included in this definition or the scope of this project.

[2] Department for Business and Trade. (2025). *The UK's Modern Industrial Strategy 2025*. Retrieved from GOV.UK: https://www.gov.uk/government/collections/the-uks-modern-industrial-strategy-2025

[3] UKRI. (2024). *Industrial Decarbonisation Challenge celebrating Our Impact*. Retrieved from https://www.ukri.org/wp-content/uploads/2024/07/IUK-29072024-Industrial-Decarbonisation-Challenge-External-Completion-Report-Digital-V1.pdf

[4] NZIW. (2025). *North East Wales Industrial Decarbonisation cluster (NEWID)*. Retrieved from https://nziw.wales/north-east-wales-industrial-decarbonisation-cluster-new-id/

[5] DESNZ. (2024). *2022 UK Greenhouse Gas Emissions*, Final Figures. Retrieved from https://assets.publishing.service.gov.uk/media/65c0d15863a23d0013c821e9/2022-final-greenhouse-gas-emissions-statistical-release.pdf?

[6] StatsWales. (2025). *Emissions of Greenhouse Gases by Year.* Retrieved from https://statswales.gov.wales/Catalogue/Environment-and-Countryside/Greenhouse-Gas/emissionsofgreenhousegases-by-year

share of emissions across the UK, where industry contributes just 14% of total emissions[5]. This shows that industrial decarbonisation is an urgent priority in Wales.

Industry in Wales faces the challenge of continuing operation in a net zero greenhouse gas economy, as committed to by Welsh and UK Government. Some industrial players have already made decisions which have led to job losses in Wales through reduction in workforce requirements, or full site closures. Preventing further de-industrialisation is vital for preserving jobs and economic value and relies on the ability of industry to decarbonise cost effectively and for this to be attractive within Wales. Decarbonising Welsh industry also offers a unique chance to lead globally in clean manufacturing, attract green investment, and secure long-term resilience for regions historically shaped by energy-intensive industry.

2.2 The potential role of hydrogen in industrial decarbonisation

Fuel switching to low-carbon hydrogen is one of a few decarbonisation options for the industrial sector in Wales and across the UK, alongside electrification. However, Welsh manufacturing's hard to abate sectors such as cement, steel, and some chemicals, undertake energy intensive processes which cannot be electrified, meaning their current only viable fuel switching option is hydrogen.

Hydrogen presents opportunities for hard-to-abate sectors as it can deliver high temperatures of over 1,500°C with a similar performance to fossil fuels[7] and releases no greenhouse gas emissions at the point of use. Hydrogen can also provide a fuel source in electrically constrained areas, replace fossil based chemical feedstocks, be scalable and be stored to provide flexibility and protect users from peak power prices.

The scale of the industrial decarbonisation challenge in Wales is significant.

- **South Wales:** Industrial and power sector Scope 1 emissions in South Wales are estimated at approximately 16 $MtCO_2e$ per year[8] . The South Wales Industrial Cluster (SWIC) anticipates that up to 47% of these emissions could be eliminated through fuel switching. The emphasis on hydrogen's role in fuel switching throughout the plan highlights the transformative potential of hydrogen deployment in the region.
- **North Wales:** In 2018, North East Wales (which covers over 95% of reported industrial emissions in North Wales) accounted for around 2 $MtCO_2e$ of industrial emissions, representing 15% of Wales's total industrial emissions[4]. Projections suggest that with fuel switching and stakeholder-led changes, emissions could fall significantly by 2040, with residual emissions of just 30 $ktCO_2e$/year, which could be offset through high-quality carbon credits to achieve net zero.

Since the UK's 2019 commitment to reaching net zero emissions by 2050, there have been numerous projects undertaken and reports published which aim to drive the decarbonisation of the industrial sector in the UK including using hydrogen.

This research builds on the high-level picture of the potential use of hydrogen within industry currently known from the Future Energy Grids for Wales, the South Wales

[7] Hydrogen UK. (2025). *Driving Demand*. Retrieved from Hydrogen UK: https://hydrogen-uk.org/publications/

[8] SWIC. (2023). SWIC Cluster Plan. Retrieved from https://www.swic.cymru/clusterplan-reports.

Industrial Cluster (SWIC) Deployment Project, the North East Wales Industrial Decarbonisation (NEWID) cluster plan, and Regional Decarbonisation Pathways reports.

This project focuses on ‘low-carbon’ hydrogen, defined by having a carbon intensity below 20g CO2e/MJLHV – as defined by the Low Carbon Hydrogen Standard (LCHS)[9]. The terms ‘low-carbon hydrogen’ and ‘hydrogen’ may be used interchangeably in this report unless otherwise specified.

[9] DESNZ. (2023). *UK Low Carbon Hydrogen Standard v3*. Retrieved from GOV.UK: https://www.gov.uk/government/publications/uk-low-carbon-hydrogen-standard-emissions-reporting-and-sustainability-criteria

3. Methodology and analysis

3.1 Methodology

The methodology for this project combined a literature review and stakeholder engagement to enable analysis, conclusions and recommendations. These conclusions were further tested with stakeholders, and Arup worked closely with stakeholders to develop recommendations for actions that reflected their priorities.

Figure 1 Overview of methodology for WIHR project.

3.1.1 Literature Review

Arup conducted an initial literature review across two distinct strands, technical and commercial research.

An initial list of technical literature was produced based on a literature search, Welsh Government suggestion, and Arup knowledge of the landscape. This initial list contained literature from UK Government, Welsh Government, regional bodies and local authorities. Arup reviewed this literature using a framework to gather information from each piece of literature relating to technologies such as hydrogen production, demand, storage and transport, as well as policy views, targets, suggested actions. As Arup reviewed the initial list of literature, further pieces of literature were identified, added to the list and reviewed. Significant pieces of literature, such as the Wales's Fourth Carbon Budget and the UK's Modern Industrial Strategy were released during the project and were reviewed upon release. Arup also reviewed any additional literature that was highlighted by stakeholders throughout the course of the project.

Since the initial publication of the UK Hydrogen Strategy in 2021, the UK Government has continued to publish a comprehensive suite of documents outlining the hydrogen policy landscape from a commercial and economic perspective, most notably the Hydrogen Business Models. These models encompass the entire hydrogen value chain, including production, transport, and storage. While the business models for storage and transport are still under development, there is substantial literature outlining their intended direction. The formal business model documentation provided the foundation of the commercial literature review. In addition to this, a range of technical documents were examined to understand the operational mechanisms of the business models and their impact on the UK hydrogen market. Furthermore, an array of professional literature was reviewed to

identify key challenges and opportunities emerging from both the design of the business models and recent policy developments in the UK and EU.

As part of the literature review, Arup also collated geospatial datasets from public sources to map the existing industrial energy demand, and existing and planned hydrogen projects and infrastructure in Wales. Arup compiled these in ArcGIS Pro to produce a baseline and future map for Wales to allow spatial visualisation of the hydrogen and industrial decarbonisation landscape. These maps were reviewed by stakeholders in Workshop 1: Action Planning.

3.1.2 Stakeholder Engagement

Stakeholder engagement was a central part of the project, used not only to validate the initial findings from the literature review, but also to expand and deepen the understanding of the hydrogen landscape in Wales. Through workshops and interviews, stakeholders contributed insights on challenges, opportunities, and potential actions, helping to shape the direction and priorities of the project. Each engagement session had a distinct purpose, of which is outlined in the sections below.

The main objectives of the engagement were:

- to test key findings of the literature review, including whether they could be validated, challenged or if additional evidence should be considered
- to test the proposed hydrogen delivery action plan, including considering priority and timeframes

Stakeholders were mapped in collaboration with the Welsh Government using an influence–interest matrix (high, medium, low). This informed participant selection for each engagement activity, ensuring representation across the hydrogen value chain and enabling a whole-systems perspective. As part of this activity, 58 potential stakeholders were identified. To ensure effective discussion and avoid overcrowding in the online forum it was agreed that not all identified stakeholders would be invited to participate in the workshops. When new stakeholders were identified, they were invited to participate.

Engagement activities were planned and delivered in accordance with a stakeholder engagement plan developed by Arup. This plan outlined the types of engagement, their timing and alignment with key tasks in this project. This included a detailed profile of each stakeholder, including organisational type, and the activities they would be invited to participate in. It was agreed that two workshops and up to eight stakeholder interviews would be the most effective engagement method.

The breadth of engagement was instrumental in shaping the project's outcomes, providing evidence-based insights that complemented the literature review and strengthened the robustness of the final recommendations.

The resources and materials used to inform the stakeholder engagement are included in Appendix A3.

Workshop 1 – Action Planning (4th June 2025)

Arup hosted the first workshop on Wednesday 4 June 2025. Representatives from 20 external stakeholder organisations were present. A breakdown of stakeholder groups involved at each stage is provided in Table 1 below:

Table 1: Stakeholder Representation in Workshop 1

	Identified Stakeholders (N=58)	Invited Stakeholders (N=42)	Stakeholder Attendees (N=20)
Industry	55%	60%	55%
Hydrogen producer	13%	19%	20%
Network operator	8%	12%	15%
Academia	7%	2%	5%
Other[10]	17%	7%	5%

The objective of workshop 1 was to present engage key stakeholders in testing and validating the findings of the literature review, identify missing evidence and agree the key challenges and opportunities for hydrogen delivery in Wales. The aims were to:

- engage key stakeholders on the objectives and purpose of the project,
- test the literature review and identify any missing information,
- review and agree opportunities and challenges, and identify any gaps,
- review and identify gaps in the technological and commercial actions.

Arup presented the findings of the literature review, including landscape overview, technological and commercial milestones, baseline and future maps of industry and hydrogen in Wales, and key challenges identified from the research to date. Suggested actions to address these were also shared. Stakeholders were asked to review the challenges, opportunities and actions, as well as identify gaps. The outputs of the activity were used to refine the list of challenges, opportunities and potential actions for the project.

Workshop 2 – Routemap Development (9th July 2025)

Workshop 2 involved representatives from 17 external stakeholder organisations. A breakdown of stakeholder groups involved at each stage is provided in Table 2 below:

Table 2: Stakeholder Representation in Workshop 2

	Identified Stakeholders (N=61)	Invited Stakeholders (N=44)	Stakeholder Attendees (N=17)
Industry	54%	57%	53%
Hydrogen producer	13%	18%	18%
Network operator	8%	11%	6%
Academia	7%	9%	18%
Other[10]	18%	5%	6%

[10] The 'Other' category included stakeholders categorised as; industry bodies, trade unions, consultant developers, growth deal partnerships and social enterprises.

The objective of workshop 2 was to prioritise actions with stakeholders which could inform the production of a routemap for industrial decarbonisation and hydrogen in Wales. The aims were to:

- engage key stakeholders in the project and progress to date,
- prioritise the actions against impact and timeframe,
- inform stakeholders of next steps in the project.

Arup presented an updated set of technical and commercial challenges and opportunities alongside potential actions, which were refined using stakeholder input from Workshop 1. Stakeholders ranked each action on a matrix against priority (scale of high to low) and timescale (2025-2035). This activity was done in four breakout rooms using a virtual whiteboard. Stakeholders were randomly assigned to different breakout rooms with an Arup member chairing the discussion in each room.

Interviews

Arup and Welsh Government jointly selected groups of participants for follow-up interviews to build on the insights gathered during the workshops. The aim of the interviews was to clarify and explore specific points in greater depth, and provide an opportunity for additional contributions from across the hydrogen value chain. Interviews were conducted over several months, depending on stakeholder availability, and took place following Workshop 1, with some continuing after Workshop 2.

Given the large number of relevant stakeholders, some interviews were conducted in groups organised by stakeholder type. Arup held six one-hour interviews involving 14 organisations which included academia, industry bodies, industrial users and hydrogen producers. Five organisations were invited but were unavailable or declined to participate in the interview process.

Stakeholders were asked tailored questions based not only on their role within the hydrogen ecosystem, but also on their experiences, challenges, and perspectives across the value chain. These questions covered topics such as challenges faced in industrial decarbonisation, supply and demand, business models, funding and investment, planning and regulation, power market structures, skills, supply chain, fuel switching, international competitiveness, R&D and ambition.

The outputs of the interviews were used by Arup both to confirm and refine earlier findings, and to directly inform the project's broader understanding of the hydrogen landscape in Wales. Stakeholders contributed new insights into challenges and opportunities, unique perspectives on how actions could be implemented, and additional evidence that helped shape the final recommendations. Further information on the interview questions can be found in A.3.4 Stakeholder interviews.

3.1.2.1 Limitations

Limitations of the engagement process are acknowledged below. These constraints mean that while the findings offer valuable insights, they may not represent the full spectrum of views across industry, infrastructure, and local communities.

- The stakeholder interviews were based on a relatively small sample size, which may not fully capture the diversity of perspectives across Wales' hydrogen value chain.

- Workshop participants were primarily drawn from organisations with existing connections to Welsh Government, and due to the need to restrict workshop size, some relevant stakeholders were not included in direct engagement.

4. Findings

The section below provides an overview of the findings of the research conducted. The findings are a culmination of the following inputs:

- Geospatial mapping undertaken by Arup, to visualise the industrial and energy landscape in Wales,
- Literature review,
- Stakeholder review, input and collaboration.

Additional contextual findings are included in Appendix A1 and Appendix A2 which cover supplementary maps as well as detail and context to the literature evidenced and discussed within this chapter, including the relevant policy landscape for hydrogen in Wales.

4.1 Project and infrastructure development

Wales has all the component parts required for the production and use of hydrogen to decarbonise industry in both North and South Wales but it needs the right support.

As described in 3.1.1 Literature Review, Arup mapped the Welsh industrial landscape alongside the existing energy infrastructure using publicly available datasets (for larger scale full page maps of Wales, North Wales and South Wales please see A.2 Geospatial analysis).

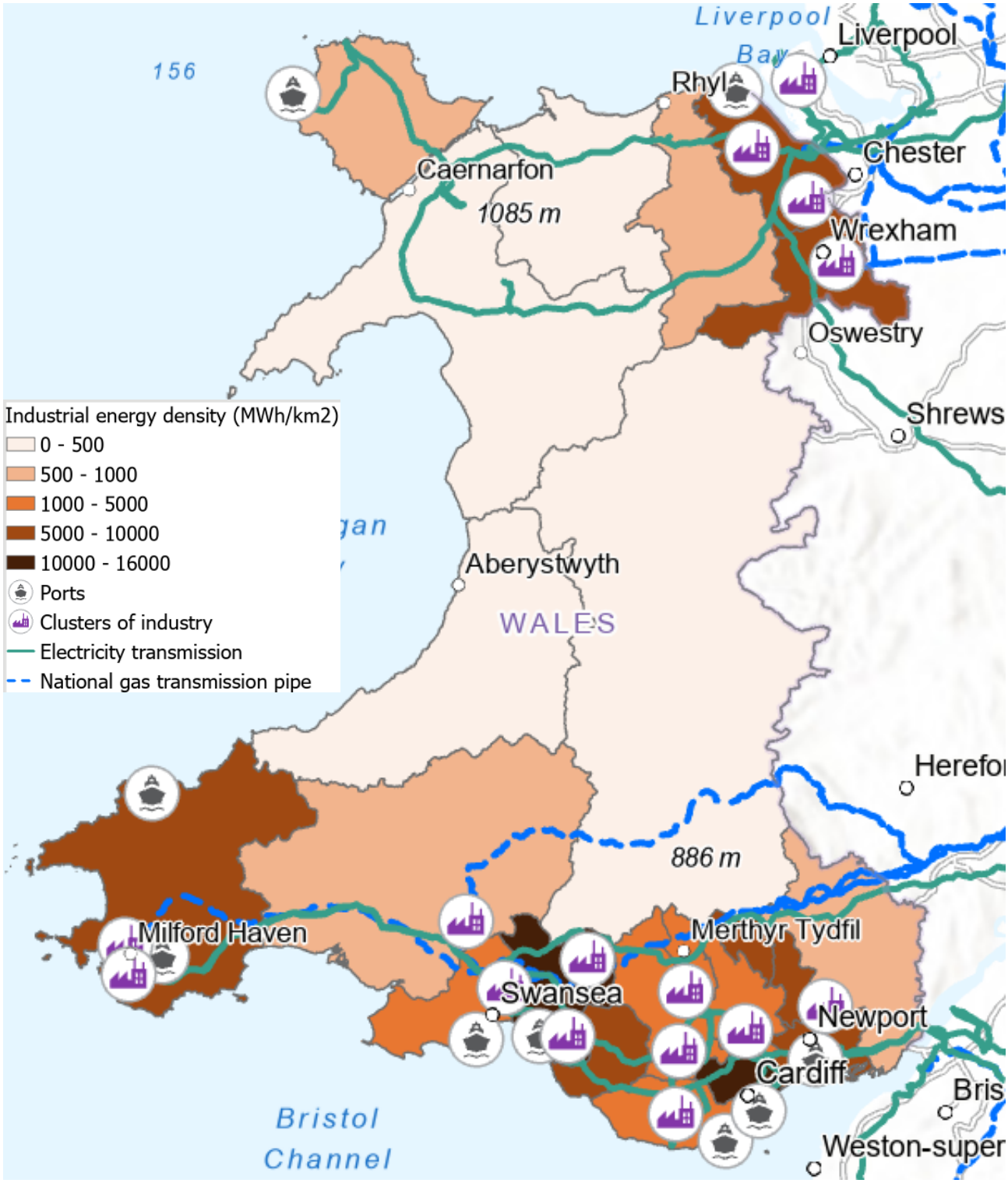

Figure 2: Map, created by Arup, of the existing energy and industrial landscape in Wales

Figure 2 shows that Wales' industrial sites are primarily located along the South Wales M4 corridor forming the South Wales Industrial Cluster (SWIC) from Newport to Milford Haven, as well as in the North East in the Wrexham and Deeside areas, forming the North East Wales Industrial Decarbonisation Cluster (NEWID).

The energy needs of these clusters are served by:

- the national gas transmission network which runs through the East of Wales to Milford Haven,
- the gas distribution network (not shown), and
- the electricity transmission system which comprises both overhead and underground cables primarily located in alignment with the location of energy intensive industry in South and North Wales.

Commercial analysis conducted for the NEWID and SWIC clusters identified hydrogen as the most viable option to decarbonise industry which cannot electrify:

- The NEWID Cluster Plan identifies hydrogen as a key fuel-switching option, with a projected demand between 740 – 1,130MW[4].
- Although the demand figures for hydrogen are not outlined, SWIC Cluster Plan identifies hydrogen as central to its decarbonisation strategy and as the most viable decarbonisation pathway for industries in South Wales which cannot electrify[8].

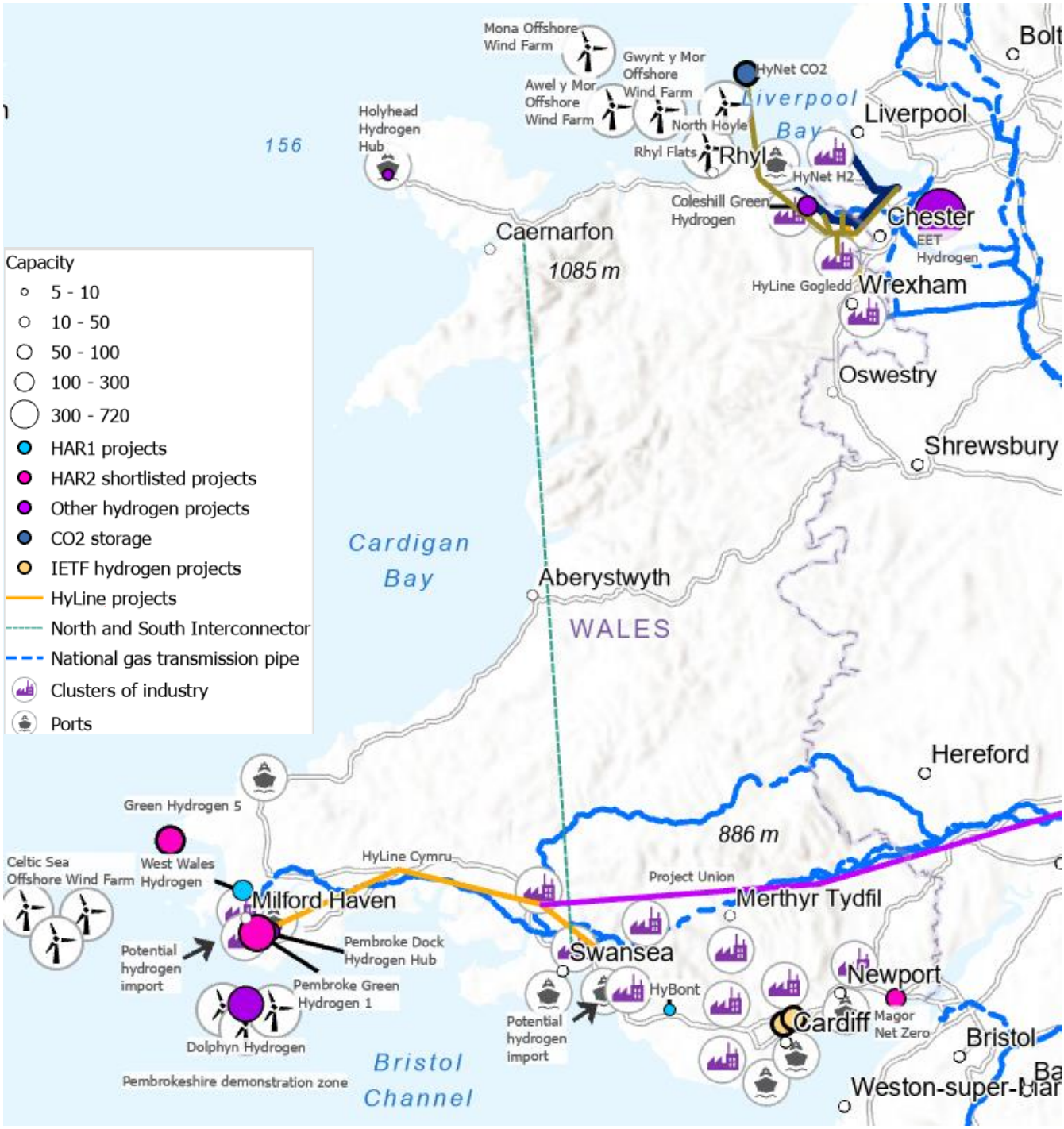

Figure 3: Map of planned and future energy infrastructure and hydrogen production projects in Wales

Figure 3 shows the planned energy infrastructure projects in Wales, including the development of hydrogen production and distribution projects.

Hydrogen production projects include:

- Hydrogen Allocation Rounds (HAR) 1 and 2 projects - (Figure 3), at project signing and shortlisting respectively, these electrolytic hydrogen production projects are located in the Pembroke, Milford Haven, Bridgend, and Caldicot areas.
- Dolphyn Hydrogen - part of the Milford Haven Hydrogen Kingdom (MH:HK) project designed to test and validate the cost benefit of offshore hydrogen production in the Celtic Sea to the consumer. Utilising the Pembrokeshire Demonstration Zone

(PDZ), a 90 km^2 test area in the Celtic Sea wind farm off the shore of South Wales, MH:HK aims to deploy floating offshore wind hydrogen production, using the Dolphyn Hydrogen technology with an eventual 300 MW generating capacity by the mid-2030s and 1 GW by 2040 onwards[11]. The project is expected to deliver £1.6bn in GVA over 20 years as well as creating 1,200 high-value jobs in the area.

The project could contribute to the UK Government's hydrogen production targets, and the hydrogen produced could be used industry that cannot electrify across South Wales, delivered through the HyLine Cymru pipeline, therefore also providing certainty to this project.

The distribution of hydrogen is expected to be undertaken via two hydrogen pipelines planned by Wales & West Utilities in South and North Wales:

- HyLine Cymru in South Wales is planned to distribute hydrogen from Milford Haven to industry along it's route to Port Talbot.
- HyLine Gogledd in North Wales is planned to distribute hydrogen from Deeside to industry in the Wrexham industrial cluster.

The freeports in Wales, combined with projects such as Celtic Sea FLOW and Dolphyn Hydrogen, present a unique opportunity to Wales[12]. The Celtic Freeport, covering Milford Haven and Port Tabot ports, will support manufacturing facilities and major port infrastructure upgrades to support the rollout of floating offshore wind in the Celtic Sea[13]. With its remit spanning clean energy development, it could also present a major opportunity for green hydrogen production, infrastructure and supply chain development, and innovation.

In North Wales, the combination of established wind farms and the Anglesey Freeport could present similar opportunities, although the literature review did not identify any current plans of this nature.

Strategic hydrogen production projects, including those from offshore wind, and infrastructure which can unlock its use at industrial sites are being planned in the right locations. However, demand, infrastructure and supply are not always timed well to maximise the commercial and economic benefits for Wales. With the right support, stakeholders could integrate the projects to create a fully functioning hydrogen economy in Wales.

[11] Dolphyn Hydrogen. (2025). Milford Haven Hydrogen Kingdom. Retrieved from: https://www.dolphynhydrogen.com/news/milford-haven-hydrogen-kingdom

[12] Welsh Gov. (2025). Freeport Programme in Wales. Retrieved from https://www.gov.wales/freeport-programme-wales

[13] Celtic Freeport. (2025). Celtic Freeport. Gateway to economic growth and innovation in Wales. Retrieved from https://www.celticfreeport.wales/

4.2 Infrastructure, business models and funding

Lack of flexibility in offtaker type and the requirement for 15-year offtake agreements in the HPBM makes it difficult for hydrogen production projects to secure long term offtake.

The literature review and stakeholder engagement with hydrogen producers identified that current business models and government financial support mechanisms lack flexibility, making it challenging to secure long-term, committed offtakers. A detailed review of both the HPBM and a report by Norton Rose Fulbright which assessed the key risks of the UKs the Low Carbon Hydrogen Agreement (LCHA) highlighted that the LCHA requires hydrogen producers to sell to a 'Qualifying offtaker'[14], which serves as a contractual foundation of the HPBM. The LCHA definition does not permit Risk-Taking Intermediaries (RTIs)[15] or hydrogen blending into the natural gas grid as qualifying offtake routes. This limits the pool of potential offtakers and requires producers to secure direct, long term contracts with end users. It is documented in the literature that producers mitigate the revenue risks associated with being heavily reliant on a small number of consumers by securing long-term 'take-or-pay' contracts (typically 15 years) which guarantee that the offtaker pays for a minimum volume of hydrogen, regardless of actual usage[14].

This challenge was consistently corroborated throughout the stakeholder engagement. It was discussed in detail in Workshop 1, highlighted as high priority and urgent issue in Workshop 2 and was central to follow-on interview discussions with hydrogen producers and industrial users.

Various stakeholder groups noted that the rigidity of the current system presents challenges for both producers and consumers, a summary of which is provided below:

- Producers highlighted that securing credible offtakers who are willing to commit to hydrogen for such an extended period (15 years) is difficult. They reported that this is due to uncertainties around volumes and reliability, as well as concerns with being locked into a higher hydrogen price when the cost of hydrogen may reduce within this timeframe.
- Industrial hydrogen users stated that the long-term contracts created significant risk for those without a stable hydrogen demand or those still exploring hydrogen as a fuel. Participants noted that the risk is compounded when considering that industry can currently purchase natural gas flexibly on the month-ahead market, with price certainty.
- Stakeholders agreed that a 15-year commitment to a single supplier was viewed as excessive and difficult to secure internal approvals, especially within large corporations.
- Potential exit costs to these contracts were cited as a barrier during stakeholder interviews.

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[14] Norton Rose Fulbright. (2023). *The UK's Low Carbon Hydrogen Agreement: How the revenue support works and key risks*. Retrieved from https://www.nortonrosefulbright.com/en/knowledge/publications/8f7105a1/low-carbon-hydrogen-agreement

[15] Risk Taking Intermediaries are firms that take custody of hydrogen from producers and sell it for profit, they are entities that purchase hydrogen for resale.

- Early offtakers stated concern over a first-mover disadvantage, with a view that as the market matures, prices may fall, and more flexible contracting arrangements may become available.

While views differed on the inclusion of RTIs and blending as viable offtake options, the overwhelming consensus was that introducing greater flexibility for offtake was a key priority that requires urgent action.

Strict offtaker eligibility criteria, and inflexible, long-term contracts can ultimately lead to a misalignment of supply and demand for hydrogen.

A lack of financial support for hydrogen fuel switching makes it difficult for potential offtakers to commit to the use of hydrogen and therefore offtake agreements.

Interviews with industry stakeholders consistently highlighted the need for support to assess the operational and technical feasibility of switching to hydrogen, and potential impact on product quality, certifications and standards. Most stakeholders highlighted a lack of demand-side incentives and funding to support hydrogen fuel switching, particularly to explore feasibility and stimulate early demand. They noted that without such funding to undertake often costly studies to explore and de-risk the fuel switching process, it is difficult for offtakers to commit to using hydrogen in their processes. This sentiment was echoed by producers, who emphasised that a dedicated fund to incentivise hydrogen fuel switching would be an effective mechanism to unlock early adoption. Most stakeholders cited the Industrial Energy Transformation Fund (IETF) as a good example of the type of support scheme that is valuable to deliver this.

During the literature review, we found that out of 160 projects funded by the IETF, Wales received support for only 15 projects[16]. As part of the engagement, some stakeholders suggested that Wales would still benefit from such a scheme to demonstrate hydrogen feasibility.

During the literature review, Arup was unable to identify any open or planned funding schemes for the use of hydrogen in industry. The UK Government announced the closure of key fuel switching scheme IETF in 2025[17]. Other historical industrial fuel switching funding schemes such as the Industrial Hydrogen Accelerator[18], Industrial Decarbonisation Challenge[19], and Industrial Fuel Switching[20] were also all found to be closed.

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[16] Tableau Public. (2025). *IETF Competition Winners*. Retrieved from https://public.tableau.com/app/profile/ietf.enquiries/viz/IETFProjectMap/MapDashboard

[17] DESNZ. (2019). *Industrial Energy Transformation Fund.* Retrieved from GOV.UK: https://www.gov.uk/government/collections/industrial-energy-transformation-fund

[18] DESNZ. (2022). *Industrial Hydrogen Accelerator Programme (competition closed).* Retrieved from https://www.gov.uk/government/publications/industrial-hydrogen-accelerator-programme

[19] UKRI. (2024). *Industrial Decarbonisation Challenge celebrating Our Impact.* Retrieved from https://www.ukri.org/wp-content/uploads/2024/07/IUK-29072024-Industrial-Decarbonisation-Challenge-External-Completion-Report-Digital-V1.pdf

[20] DESNZ & BEIS. (2022). *Industrial Fuel Switching Competition Phase 2: demonstration projects (closed to applications*. Retrieved from GOV.UK:

Without financial support to investigate the impacts of switching to hydrogen, offtakers are unlikely to take on the risk of switching their process fuel to hydrogen in the UK and ultimately risks deindustrialisation of Welsh industry.

Hydrogen producers need long-term power contracts and aligning CfD incentives with this need could unlock greater participation from renewable electricity generators in electrolytic hydrogen project.

Literature produced by Renewable UK, which discusses how to reduce the cost of electrolytic hydrogen to accelerate deployment, highlighted that a key challenge for electrolytic hydrogen projects is the misalignment between their need for long-term, fixed-price Power Purchase Agreements (PPAs) and the CfD scheme for renewable generators. The literature states that the current design of the HPBM means it is difficult for hydrogen producers to contract with renewable generators that hold a CfD. This is because hydrogen producers seek longer term price certainty to manage exposure to volatile electricity markets, especially given the lack of indexation to electricity prices in the HPBM, whereas CfD-backed generators are incentivised to sell power in the 'Day Ahead' market to maximise CfD payments[21]. This structural disconnect discourages renewable generators from entering long-term PPAs with hydrogen producers, given the lack of financial incentive for them to do so.

The stakeholder interviews with hydrogen producers reinforced the findings of the literature review. Producers noted that 15-year PPAs are particularly challenging, as they often require the purchase of more electricity than is needed to ensure steady-state hydrogen production. The surplus may then be needed to be sold back to the market, which introduced further financial risk and complexity, hence the inability to optimise electricity use and pricing over such long timeframes is a major barrier to project viability.

Some stakeholders also raised concerns about counterparty risk, especially when both the hydrogen producer and the renewable generator are seeking long-term contractual certainty. The lack of flexibility in current PPA structures, combined with the absence of indexation to electricity prices in the HPBM, further complicates efforts to manage exposure to volatile power markets. Due to the lack of support for transport and storage, co-location between hydrogen production and renewable generation was identified by several stakeholders as a significant constraint, particularly in terms of electrical infrastructure and grid capacity. A number of interviewees emphasised that without mechanisms to support more flexible and optimised power contracting, such as transport and storage solutions or revised CfD structures, the economic case for electrolytic hydrogen would weaken.

Applicants to the hydrogen business model processes require clarity and certainty with respect to timelines, processes, eligibility, alignment and integration across production, storage and distribution.

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https://www.gov.uk/government/publications/industrial-fuel-switching-competition-phase-2-demonstration-projects

[21] Renewable UK. (2025). *Splitting the Difference*. Retrieved from https://www.renewableuk.com/media/gjkhpx2n/splitting-the-difference-hydrogen-co-report.pdf

During the project workshops and interviews, stakeholders were united in their views that there is a need for greater clarity on the HARs including timelines, assessment criteria and processes.

Hydrogen producers reported that delays to the HAR2 shortlisting announcements and unexpected communication voids during the application process created significant uncertainty and affected market confidence, both from offtakers and investors. Delays and uncertainty coupled with high upfront development expenditure (DEVEX) meant many producers were forced to work at risk with some smaller developers put under significant financial strain. Stakeholders, in particular hydrogen producers, highlighted in interviews that uncertainty and prolonged timescales through the HARs does not support investment planning. They noted that it risks the market becoming concentrated only with developers who can afford to absorb high DEVEX costs, which could undermine competition and innovation.

Additionally, many stakeholders stated that short notice timelines for the submission of applications made it difficult for developers to mobilise the necessary resources.

Several interviewees made clear that this uncertainty for producers has downstream consequences for industrial offtakers, who require confidence in project timelines and delivery to justify switching from low-risk, business-as-usual natural gas inputs to hydrogen. Hydrogen offtakers emphasised that what they need most is *"more clarity and lower uncertainty to reduce risk"*. This issue became a central topic in Workshop 2, where it was discussed as both high priority and urgent.

Several stakeholders also reported that it is unclear how the HTBM and HSBM will integrate and work with the HPBM, including who will pay at each stage of the hydrogen value chain. This uncertainty is especially challenging given the high upfront costs faced by network operators. Many hydrogen projects, including in Wales, have complex production, storage, transport and consumption components. Both producers and offtakers reported the need for clarity and commitment from UK Government on the HTBM and HSBM, including design, timescales, assessment and assessment criteria. This point was reinforced in the literature, with a report by Offshore Energies UK acknowledging the importance of transport and storage infrastructure in kickstarting the sector and stating that the co-development of the HTBM and HSBM will offer increased certainty for investors and de-risk early-stage projects[22].

While the Government has published its 'minded-to' positions for the HTBM and HSBM, as well as its intent to launch these later in the first half of 2026, detailed guidance is urgently needed to support project development. Developing a hydrogen market requires integrated, targeted support for network operators facing high upfront costs.

Funding and timing certainty for HyLine Cymru and HyLine Gogledd to progress through FEED and into construction is crucial to Wales, without which, both the NEWID and SWIC clusters will be unlikely to secure hydrogen for hard-to-abate industry, risking deindustrialisation.

The literature review found that the NEWID and SWIC clusters are home to industry with processes that cannot be electrified and require high grade heat, which can be provided by hydrogen[4].

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[22] Offshore Energies UK. (2025). *Hydrogen Insight 2025*. Retrieved from https://oeuk.org.uk/product/hydrogen-insight-2025/

A stakeholder engaged noted that without pipeline transport of hydrogen, the volumes required by potential industrial offtakers is too great to be delivered by road transport (i.e. tube trailers). As such, both the NEWID and SWIC clusters are reliant on the WWU planned hydrogen pipelines, HyLine Gogledd and HyLine Cymru respectively, to deliver hydrogen to potential industrial offtake sites. Without these, Wales risks these industries relocating to areas with a hydrogen supply.

The recent Ofgem determinations did not approve WWU's request for £23m to undertake the FEED study for HyLine Cymru, the most well-developed of their planned Welsh hydrogen pipelines[23]. One stakeholder raised concern that Ofgem had however supported Project Union and East Coast pipelines. Ofgem reported that the decision was based on its assessment that HyLine Cymru's needs case was less urgent and offered lower consumer value compared to other proposals. Although, this reflects Ofgem's current strategic priorities and readiness levels and does not necessarily indicate a lack of support for Welsh infrastructure, without certainty with respect to Wales' planned hydrogen pipelines, stakeholders expressed concern over the future of industry in Wales.

Ofgem referred WWU to the upcoming HTBM as a potential funding route and is likely to set a precedent for other hydrogen pipeline projects including HyLine Gogledd.

None of the stakeholders engaged knew when the HTBM will launch or how it will work in practical terms both as a scheme or in relation to the HPBM and HSBM. However, some stakeholders noted that they understand that the HTBM will not fund FEED studies and therefore will not be an option to undertake the HyLine FEED studies. In addition, they did not know of any other funding routes that could be available to the HyLine projects to undertake the costly FEED study required. As such stakeholders were clear that without support in the way of funding, the HyLine projects may stall, and delays and uncertainty risk further deindustrialisation in Wales. Some stakeholders suggested that in absence of HTBM funding for HyLine Cymru, Welsh Government should consider working with UK Government to find routes to supporting this nationally significant project.

4.3 Shared narrative and strategy

Wales needs a clear narrative and strategy for hydrogen across the value chain and its use in industrial decarbonisation to promote growth, investment and skills.

UK Government published the UK Hydrogen Strategy in 2021[24] as a comprehensive plan to develop a low-carbon hydrogen economy. The strategy outlines an ambition to make the UK a *"global leader on hydrogen"* with 5 GW of low-carbon hydrogen production capacity by 2030. The strategy outlines that at the time there were very few low-carbon hydrogen production projects currently operational in the UK but predicted that hydrogen

[23] Ofgem. (2025). *RIIO-2 NZASP Re-opener Final Determinations: East Coast and HyLine Cymru Hydrogen Network FEED Studies.* Retrieved from https://www.ofgem.gov.uk/sites/default/files/2025-06/Final%20Determinations%20East%20Coast%20and%20Hyline%20Cymru%20Hydrogen%20Network%20FEED%20studies.pdf

[24] DESNZ. (2021). *UK hydrogen strategy*. Retrieved from https://www.gov.uk/government/publications/uk-hydrogen-strategy

will play a significant role in the future energy mix, making up an estimated 20 to 35% of total energy consumption in 2050.

The UK ambitions for hydrogen were later updated as part of the British Energy Security Strategy in 2022 which doubled the previous ambition to 10 GW of low-carbon hydrogen production by 2030, with at least half to come from electrolysis[25]. This also outlined support for hydrogen blending with natural gas, establishing a certification scheme and running production allocation rounds which were later established.[26] [27]

These stated ambitions have been useful in providing strategy, direction and funding for hydrogen production in the UK. A paper by Hydrogen UK states that a robust hydrogen strategy will *"directly support developer and offtaker planning, driving investment and partnership agreements"*[7]. UK Government also introduced the Net Zero Hydrogen Fund (NZHF) (waves 1 & 2) to provide up to £240million of CAPEX and DEVEX for low carbon hydrogen projects.

The UK Government has committed to publishing an updated Hydrogen Strategy in Autumn 2025 and its most recent update to market (July 2025) reiterated that the UK Government is *"serious about hydrogen"*.

Whilst the UK Hydrogen Strategy highlighted Wales' potential for low carbon hydrogen production and use, the research exposed that there are no official stated ambitions for hydrogen production in Wales.

As part of the both the workshops and interviews, many stakeholders expressed strongly that Wales requires a shared narrative for hydrogen that industry can get behind. When Arup highlighted the lack of Welsh Hydrogen Strategy, all stakeholders agreed with the need for Wales to develop a clear strategic direction for hydrogen, part of a Hydrogen Strategy for Wales that sets out hydrogen production ambitions and targets, as well as a roadmap for its use in industrial decarbonisation to promote growth and investment.

Examples of comments made during the workshops and interviews include:

- *"A hydrogen vision might be needed from Welsh Government" – Industry body*
- *"It is really important that each nation has its own clear ambitions and shows how these fit in with the UK context..." – Industry body*
- *"a strategy can give direction and build confidence" – Industry*
- *"a strategy would show that Welsh Government is fully committed – it would lay out what Wales can do to deliver on UK priorities, but in Wales" – Hydrogen producer*

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[25] DESNZ. (2022). *British energy security strategy*. Retrieved from https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy

[26] DESNZ. (2023). *Hydrogen blending into GB gas distribution networks*. Retrieved from https://www.gov.uk/government/consultations/hydrogen-blending-into-gb-gas-distribution-networks

[27] DESNZ. (2023). *UK Low Carbon Hydrogen Certification Scheme*. Retrieved from https://www.gov.uk/government/consultations/uk-low-carbon-hydrogen-certification-scheme

Stakeholders expressed mixed views on the importance of a skills strategy in supporting hydrogen development. Some stakeholders emphasised the need for upskilling existing roles, particularly in response to retirements and emerging technical demands. One interviewee noted, *"In terms of skills, less so new jobs but more upskilling of existing jobs… numbers suggest high demand with a potential gap in the pipeline"* and shared that their organisation was considering adjustments to its skills programmes. Discussions also highlighted regional variation in skills needs, with specific technical expertise (e.g. instrumentation and electrical) being particularly relevant in South Wales. There was concern that current strategies focus too broadly on 'net zero' or 'green skills' without clearly defining what that means for hydrogen, and some stakeholders called for Welsh Government to provide clearer guidance on the types and numbers of roles needed across the hydrogen value chain.

However, others felt that the skills challenge would resolve itself over time and did not see the need for a dedicated hydrogen skills strategy. One group placed less emphasis on skills, suggesting that broader workforce trends would naturally adapt.

Arup also investigated literature around skills in hydrogen. The UK Industrial Strategy[2] makes the case that there is a significant skills shortage and that the current system is failing to meet the flexible requirements of industry. The UK Hydrogen Strategy also calls for strategic direction on skills and supply chain[28]. Since then, the Hydrogen Skills Alliance (HSA) has undertaken a Hydrogen Workforce Assessment[29] and Strategic Skills Plan for UK Hydrogen[30], with a Hydrogen Skills Framework in development.

The mixture of views suggests that skills for hydrogen need consideration, but a dedicated skills strategy may be too much at this stage in time.

Increased advocacy for Welsh industry, clusters and projects may better position Wales for success, especially as the UK Government develops initiatives such as the British Industrial Competitiveness Scheme and Gas Shipper Obligation, amongst other strategic policies.

Throughout the stakeholder engagement conducted, there was a strong emphasis on how strategic UK Government policy design and decisions have significant impacts for Welsh industry and consumers. There were clear messages that arose from the engagement:

- Wales does not need to take a fundamentally different approach, it should link up with the rest of the UK,
- Welsh voices need to be heard more clearly across Westminster, as there is limited representation currently particularly regarding hydrogen and policy.

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[28] DESNZ. (2021). *UK Hydrogen Strategy*. Retrieved from https://www.gov.uk/government/publications/uk-hydrogen-strateg

[29] HSA. (2024). *Hydrogen Workforce Assessment*. Retrieved from https://cogentskills.com/wp-content/uploads/2024/07/Hydrogen-Workforce-Assessment-Executive-Summaryfinal.pdf

[30] HSA. (2025). *Strategic Skills Plan for UK Hydrogen*. Retrieved from https://cogentskills.com/wp-content/uploads/2025/01/Hydrogen_Skills_Alliance_Plan25_final.pdf

Several stakeholders stated that without input from key Welsh parties and consideration for the nation's specific context, there is a risk that these policies could lead to unintended consequences or fail to deliver the intended benefits for Wales' hydrogen economy.

The literature and current allocation of UK Government funding for hydrogen projects reinforces this point. Wales has had less success through the HAR rounds than Scotland and England. Two of the projects successful in HAR1 are in Wales, compared to two in Scotland and seven in England[31]. In the HAR2 shortlist, Wales has three projects compared to eight in Scotland and 16 in England[32]. Overall, this equates to a 13% share in Wales, compared to 26% in Scotland and 61% in England. Likewise, out of 160 projects funded by the IETF, Wales received support for 15 projects, compared to 21 in Scotland, 12 in Northern Ireland, and 124 in England[33].

Many stakeholders highlighted that increased advocacy for Welsh industry and projects is essential to improve these figures. The role of Welsh Government in championing Welsh interests was a key topic of discussion in the workshops. Through the literature review, several upcoming opportunities were identified where Welsh Government could work closely with UK Government to influence strategic decisions and communicate the potential impact on Welsh industry:

1. **British Industrial Competitiveness Scheme** (stated in the Modern Industrial Strategy): is forecast from 2027 to reduce electricity costs by around £35/MWh up to 2030. Eligible businesses will be exempt from paying the costs of the Renewables Obligation, Feed-In Tariffs and the Capacity Market[2]. Many manufacturing firms in Wales that are exploring hydrogen as a fuel switching option are facing issues of cost competitiveness on an international scale due to relatively high prices of wholesale electricity in the UK, highlighted extensively in the interviews with industry. Without support, the literature states that there is a risk of de-industrialisation in Wales, underscoring the need for Welsh Government to advocate for inclusion of Welsh businesses in the scheme's eligibility criteria.
2. **Gas Shipper Obligation:** a proposed levy on gas shippers in the UK from 2027 onwards. It is aimed at being the long-term funding mechanism for the HPBM[34]. While it may marginally increase costs for consumers and businesses, it also presents a strategic opportunity to accelerate decarbonisation of Welsh

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[31] DESNZ. (2023). *Hydrogen Production Business Model / Net Zero Hydrogen Fund: HAR1 successful projects.* Retrieved from https://www.gov.uk/government/publications/hydrogen-production-business-model-net-zero-hydrogen-fund-shortlisted-projects/hydrogen-production-business-model-net-zero-hydrogen-fund-har1-successful-projects

[32] DESNZ. (2025). *Hydrogen Allocation Round 2 (HAR2): shortlisted projects*. Retrieved from https://www.gov.uk/government/publications/hydrogen-allocation-round-2-har2-projects/hydrogen-allocation-round-2-har2-shortlisted-projects

[33] Tableau Public. (2025). *IETF Competition Winners*. Retrieved from https://public.tableau.com/app/profile/ietf.enquiries/viz/IETFProjectMap/MapDashboard

[34] DESNZ. (2025). *Funding mechanism for the Hydrogen Production Business Model: Consultation on the proposed Gas Shipper Obligation*. Retrieved from https://www.gov.uk/government/consultations/funding-mechanism-for-the-hydrogen-production-business-model-proposed-design-of-the-gas-shipper-obligation

infrastructure and industry, for example at established liquefied natural gas terminals such as Milford Haven.

3. **Great British Energy:** Established in October 2024 as a publicly owned, clean-energy company, GBE has a mission to help Britain become a Clean Energy Superpower while spreading benefits to every corner of the UK. With £8.3 billion to invest in clean energy over the current parliament[35], it offers a strategic opportunity to de-risk hydrogen projects in Wales through public investment and risk-sharing, helping to accelerate deployment and attract private capital.

In addition, industrial stakeholders emphasised the importance of Welsh Government increasing its advocacy for Welsh industrial clusters. To fully capitalise on the opportunities in Wales, several stakeholders suggested that advocacy is required on a national and international level to attract investment. This is also reflected in public comments with NZIW stating, *"Wales needs to be more assertive in securing UK Government support"*[36].

There is an opportunity for Welsh Water and the future national water authority for Wales to develop strategic plans for the use of water for hydrogen production in future planning.

Electrolytic hydrogen production involves the splitting of water using electricity to create hydrogen. Whilst required water quantities varies depending on electrolyser technology and water source, a high-level estimate of 50 -75 litres/kgH_2 can be used for electrolytic water demand[37]. Water is also required for production of "blue" hydrogen for both the steam methane reforming process and the CCUS, as a coolant. Approximately 22-29 litres/kgH_2 of water is required to produce hydrogen through SMR with CCUS[37].

UK Government estimates that water use for hydrogen could reach up to 0.4% of the national water demand in 2035. In the Water Demand for Hydrogen Production report, they state *"Whilst the water demand for hydrogen production ranks low compared with other sectors, consideration must be given to the water system both as a whole and at a more local level, particularly in areas where water stress is a current or growing concern"*[37].

An Independent Water Commission[38] examining water industry regulation has recommended a single national water authority to regulate water for Wales. The Commission also recommends clearer strategic direction, including a National Water Strategy to be published by UK and Welsh Governments, with a clear framework for managing water demand for at least the next 25 years.

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[35] DESNZ. (2025). *Great British Energy Act 2025: factsheet.* Retrieved from https://www.gov.uk/government/publications/great-british-energy-bill-factsheets/great-british-energy-bill-overarching-factsheet

[36] NZIW. (2025). *NZIW*. Retrieved from https://nziw.wales/how-wales-can-be-a-leading-clean-energy-transition-hub-and-a-cornerstone-of-the-uk-industrial-base/

[37] DESNZ. (2024). *Water Demand for Hydrogen Production*. Retrieved from https://assets.publishing.service.gov.uk/media/680b9752b0d43971b07f5ba7/water-demand-for-hydrogen-production.pdf

[38] Independent Water Commission (2025). *Roadmap to rebuild trust in water sector unveiled in major new report*. Retrieved from https://www.gov.uk/government/news/roadmap-to-rebuild-trust-in-water-sector-unveiled-in-major-new-report

As the electrolytic hydrogen production capacity alone for planned projects in Wales is estimated to be over 170 MW, significant quantities of water are likely to be required by Wales for hydrogen production. The SWIC cluster plan suggested that a strategic water supply plan is needed[39] but such a strategic plan was not found as part of the research undertaken in this project. Water demand was also identified as a key challenge for hydrogen production in an interview with hydrogen producers. The Water Resources Management Plan 2024 by Welsh Water[40] does not currently include consideration of water demand for hydrogen production.

Stakeholders were asked for their thoughts on this finding in Workshop 1. One stakeholder commented that *"Welsh Water are aware of the opportunity to co-invest in water capture and storage to supply hydrogen production and simultaneously reinforce their network"* although Welsh Water were not in attendance and therefore Arup was unable to verify this claim.

The combined lack of strategic water plans including hydrogen and the challenge highlighted by stakeholders suggests that Wales would benefit from strategic water planning in relation to hydrogen.

4.4 Policy, regulation and consenting

Addressing grid connection delays, capacity constraints and affordability would accelerate hydrogen projects.

Throughout the workshops and interviews, most stakeholders reported that the electrical connections process to date has been ineffective for hydrogen production projects. They noted that this was because it does not allow the separation of technologies, does not link to the government's strategic objectives for hydrogen, and inhibits grid connection certainty which can impact confidence in projects and therefore their planning and funding.

Some stakeholders reported waiting times of 10 years to achieve a grid connection in some instances, which has caused some project developers to reconsider their plans; in March 2024, a 15 MW electrolysis plant planned by Statkraft in Pembrokeshire was paused indefinitely because *"obtaining the necessary grid connection will take a number of years, considerably longer than initially anticipated"*[41].

The National Energy System Operator (NESO) is currently reforming the grid connection process to address a backlog of projects and applications. NESO are replacing the *"first-come, first-served"* model to prioritise projects based on readiness and strategic

[39] South Wales Industrial Cluster. (2023). *South Wales Industrial Cluster Plan Report*. Retrieved from https://www.swic.cymru/clusterplan-reports

[40] Welsh Water. (2024). *Final Water Resources Management Plan 2024*. Retrieved from https://www.dwrcymru.com/en/our-services/water/water-resources/final-water-resources-management-plan-2024

[41] Western Telegraph. (2024). *Development of controversial green hydrogen plant paused*. Retrieved from https://www.westerntelegraph.co.uk/news/24172266.development-controversial-green-hydrogen-plant-paused/

alignment[42]. Although stakeholders welcomed this process overall, some reported that this reform introduces new issues around shared liabilities and interdependencies. Hydrogen producers reported that they often rely on co-located or partnered projects to secure grid access and if a partner project is delayed, deprioritised, or removed from the queue, it can jeopardise the hydrogen producer's own connection, even if they retain their place.

Hydrogen producers also cited a requirement, through the HPBM and LCHS, for them to prove the green credentials of electricity[43]. They reported that this is not the case for others such as data centres or vehicle chargers and perceived this as unfair or in some cases a perceived bias against the use of hydrogen.

Many stakeholders also highlighted the cost of electricity as a major barrier. Electricity costs can account for up to 70% of the levelised cost of hydrogen, with nearly half of this stemming from the electricity system[44]. The literature review showed that this exposure is exacerbated by the strike price through the HPBM being indexed to the Consumer Price Inflation (CPI), which does not reflect fluctuations in electricity prices. UK electricity prices are significantly higher than in most competing economies, particularly across Europe and North America. In 2025, energy-intensive firms in the UK paid nearly double the European average for electricity[2].

The combination of these factors was reported in interviews and workshops as making it difficult for producers to get hydrogen production projects off the ground and if solved could improve project certainty, confidence and affordability moving forward.

The divergence between UK and EU regulation and policy creates divergence and could impact business competitiveness and certainty.

The UK's Modern Industrial Strategy, published in June 2025, recognised the need to enhance energy cooperation with the EU, particularly through linking the UK and EU Emissions Trading Systems (ETS). This could create a more stable and liquid market[2] given the relatively smaller scale of UK's standalone ETS and carbon market.

The literature review highlighted several concerns arising from a lack of cooperation with the EU:

- **Market volatility and uncertainty:** The smaller, more volatile nature of the standalone UK carbon market creates uncertainty for businesses, making investment in decarbonisation technologies less commercially attractive. While there might be some short-term upwards adjustments, in the medium to long term, a standalone UK ETS

[42] NESO. (2024). *Great Britain's Connections Reform: Overview Document*. Retrieved from https://www.neso.energy/document/346816/download

[43] The current criteria are that each consignment of hydrogen: (i) has a GHG emissions intensity of 20gCO2e/MJLHV of hydrogen produced or less; and (ii) has been produced by a hydrogen production facility which satisfies the 'Conditions of Standard Compliance' (as specified in the LCHS).

[44] The Energy Landscape. (2024). *Green hydrogen in Scotland - A report for Scottish Futures Trust*. Retrieved from https://www.scottishfuturestrust.org.uk/publications/documents/green-hydrogen-in-scotland

could result in UK businesses facing a higher carbon price than if the schemes were linked[45].

- **Exposure to CBAM payments:** Without a linking agreement, UK exporters in sectors covered by the EU CBAM risk facing substantial payments, potentially up to £800million annually to the EU by 2030[46]. This directly undermines the competitiveness of British companies in EU markets and is directly relevant for a number of Welsh manufacturers who compete in European markets.

These concerns were echoed throughout stakeholder engagement, especially during workshops, where participants consistently emphasised the urgency of progressing towards ETS linkage to mitigate the effects of the EU CBAM on UK industry and trade. All stakeholders viewed the agreement at the EU-UK summit to link EU and UK ETS's as a positive first step to achieving alignment, providing certainty for industry, removing challenges to trade and encouraging investment in clean technologies. However, full linkage was widely regarded as essential to safeguard UK industrial competitiveness and unlock cross-border trade opportunities.

Research by Offshore Energies UK highlighted an additional challenge for UK industry trying to access the EU market, in particular regarding the difference in definitions of low carbon hydrogen. The EU definition of low-carbon hydrogen *is "hydrogen derived from non-renewable sources that meets a GHG emissions reduction threshold of 70% compared to a fossil fuel comparator"*[47]. In the UK, low-carbon hydrogen *"must emit no more than 20g CO_2e per megajoule of hydrogen produced"*[9]. The difference in standards, particularly in how emissions are measured, evidenced and subsequently how compliance is shown, could create challenges for cross-border trade of hydrogen between the UK and EU, limiting the UK's ability to fully capitalise on export opportunities to the EU[22]. However, this issue received comparatively less concern during stakeholder engagement. While it was acknowledged as a potential barrier, few stakeholders had encountered it directly. Instead, discussions primarily focused on ETS linkage and CBAM, which were seen as having more immediate and direct implications for costs, competitiveness, and the availability of investment for decarbonisation.

Streamlining the hydrogen planning landscape and improving clarity and alignment between HSE and planning regulations, would provide greater certainty and help developers and accelerate project delivery.

Several stakeholders reported a perception that current processes are lengthy, complex, and resource-intensive, making them difficult for developers to navigate, adding considerable cost and delay to project timelines. Additionally, research from DESNZ found that inconsistencies across UK nations, limited institutional experience with hydrogen, and

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[45] Energy UK. (2025). *Energy UK explains: Linking the UK and EU Emissions Trading*. Retrieved from https://www.energy-uk.org.uk/wp-content/uploads/2025/05/Energy-UK-Explains-Linking-the-UK-and-EU-Emissions-Trading-Schemes-8-May-2025.pdf

[46] Prime Minister's Office. (2025). *PM secures new agreement with EU to benefit British people*. Retrieved from https://www.gov.uk/government/news/pm-secures-new-agreement-with-eu-to-benefit-british-people

[47] European Parliamentary Research Service. (2025). *Renewable and low-carbon hydrogen: State of play and outlook*. Retrieved from European Parliament: https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2025)767227

capacity constraints within planning authorities compound the challenge[48], creating uncertainty and slowing progress.

In the stakeholder interviews, when asked if there any specific regulations that have limited the use of hydrogen in Wales, one stakeholder highlighted negative experiences with permitting processes and indicated that the issue was more significant in Wales. When asked the same question, another stakeholder highlighted that they had received mixed messages regarding the requirement for an Environmental Impact Assessment leading to last minute requests for information from the project. Another stakeholder said, *"planning has been a real struggle"* and commented on a lack of planning resource and unhelpful recommendations from HSE which led to months of delays to their project, before stating *"more resource and engagement on planning from Welsh Government would be helpful".*

HSE has identified that planning regulations use a lower consent threshold (2 tonnes) than COMAH (5 tonnes)[49]. While HSE note that guidance is evolving to reflect emerging scientific evidence, it is acknowledged by HSE that it is challenging to "*consider revisions to legislation with limited resources"*[49]. This will be more acute for less experienced developers, who may struggle to navigate complex and changing requirements. The evolving nature of the guidance adds further uncertainty, making it harder to keep pace with regulatory expectations.

Efforts are underway to streamline consenting through the Planning and Infrastructure Bill in England[50]. As England reduces timescales for consenting, Wales needs to keep pace to ensure it does not lose out on investment opportunities.

Proactive community engagement and clear communication of local benefits can help overcome public opposition to hydrogen projects, easing planning approval and reducing delays.

Literature research demonstrated that there has been previous challenge in Wales around the public acceptance of hydrogen in Bridgend - the HyBont project in Bridgend received a negative public response during the planning phase[51].

During interviews, some stakeholders commented on how negative community engagement and media reports have been unhelpful to planning processes and project acceptance and timelines. In workshop 2, many stakeholders stressed the importance of positive public perceptions and narratives around hydrogen projects and safety to prevent local or national political setbacks to projects.

Some stakeholders highlighted how community engagement has been supported and handled positively in similar energy infrastructure projects. One stakeholder referenced

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[48] DESNZ. (2025). *Hydrogen projects: planning barriers and solutions.* Retrieved from GOV.UK: https://www.gov.uk/government/publications/hydrogen-projects-planning-barriers-and-solutions

[49] HSE. (2024). *Hydrogen infrastructure in the UK: Regulatory challenges and scientific knowledge gaps*. Retrieved from https://minerva.jrc.ec.europa.eu/en/shorturl/minerva/gant_mccann_2402045_eu_oecd_hydrogen_webinar_hse_v3pdf

[50] Guide to the Planning and Infrastructure Bill - GOV.UK

[51] BBC News. (2023). *Green energy: Bridgend council pulls £6.5m HyBont funding*. Retrieved from https://www.bbc.co.uk/news/uk-wales-66854183

successes from the UK Government resource kit that outlines community benefits guidance for onshore wind in England[52]. This provides successful case studies, a community action plan, guidance for applicants and a community benefits agreement template to support developers with community engagement.

4.5 Collaboration and engagement

Welsh industrial clusters need connections to infrastructure in England in order to enable access to the volumes of hydrogen required to decarbonise industry. Collaboration and engagement is critical to enable this.

The literature review showed that there are planned infrastructure projects planned to cross into Wales from England, such as HyNet (both hydrogen and CCUS) and Project Union, which could benefit Wales' hydrogen economy.

The NEWID cluster plan highlights the importance of connecting North East Wales to the HyNet hydrogen pipeline[4]. This connection is expected to be delivered through HyLine Gogledd and enable the supply of blue hydrogen from North West England[53] to industrial hubs and the NEWID cluster.

National Gas reports show that Project Union, the UK-wide hydrogen transmission network, is planned to connect South Wales and HyNet with the hydrogen backbone, presenting a strategic opportunity to supply Welsh industry with hydrogen[54].

These plans evidence Wales' reliance on England's energy infrastructure plans. This is particularly significant in NEWID, where without a connection to HyNet, it is unclear how enough hydrogen will be secured to decarbonise the cluster.

Some contributors expressed concern that Wales may be one of the last regions to connect to Project Union, citing both technical and commercial challenges. One stakeholder stated, *"Wales will be one of the last areas to be connected to Project Union, if at all".* Reliance on England also extends to hydrogen storage. Several stakeholders mentioned the lack of large-scale geological hydrogen storage options in Wales and highlighted potential storage opportunities in England. One stakeholder suggested that, if large scale hydrogen storage is required in Wales, then cross-border sharing of infrastructure may be required.

Both the NEWID cluster plan and most stakeholders engaged as part of the interviews and workshops expressed that Wales' reliance on infrastructure being developed over the

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[52] DESNZ. (2025). *Community benefits guidance for onshore wind in England: resource kit (accessible webpage)*. Retrieved from GOV.UK: https://www.gov.uk/government/publications/community-benefits-and-engagement-guidance-for-onshore-wind/community-benefits-guidance-for-onshore-wind-in-england-resource-kit-accessible-webpage

[53] WWU. (2025). *Wales & West Utilities announces plans to boost North East Wales industrial decarbonisation*. Retrieved from https://www.wwutilities.co.uk/news-and-blog/wales-west-utilities-announces-plans-to-boost-north-east-wales-industrial-decarbonisation/

[54] National Gas. (2025). *Project Union*. Retrieved from https://www.nationalgas.com/future-energy/hydrogen/project-union

border in England means that close ties need to be forged. It was raised that Welsh Government could play an important role in advocating for and communicating the case and mutual benefit of access for NEWID to the HyNet hydrogen pipeline, and South Wales to project union, with UK Government and National Gas.

5. Action plan

The findings and associated actions were developed through a combination of evidence gathered from the literature review as well as stakeholder workshops and interviews where actions were developed, tested, refined and prioritised. The actions, mapped to each of the findings, are presented in the Action Plan below (Table 3). The main findings and actions prioritised during the stakeholder workshop, in each category, are presented in bold text.

Table 3: Action Plan

Theme	Findings, challenges and opportunities	Recommended action	Action owner
 **Infrastructure, business models & funding**	Lack of flexibility in offtaker type and the requirement for 15-year offtake agreements in the HPBM makes it difficult for hydrogen production projects to secure long term offtake.	**Introduce more flexibility for offtakers under the HPBM.** e.g. allow RTIs and gas grid blending, to reduce offtaker risk for production projects.	**UK Government**
	The lack of financial hydrogen fuel switching support make it difficult for potential offtakers to commit to the use of hydrogen and therefore offtake agreements.	**Incentivise industrial fuel switching through targeted financial support mechanisms.** This should be akin to the Industrial Energy Transformation Fund, allowing potential offtakers to test and de-risk fuel switching of their processes to hydrogen. Work with industry to find ways to share learnings from IETF and other industrial decarbonisation projects with industry to maximise the value of this and other schemes.	**UK Government**
	Hydrogen producers need long-term power contracts and aligning CfD	**Align the HPBM with CfD-backed renewable generators.**	**UK Government**

	incentives with this need could unlock greater participation from renewable electricity generators in electrolytic hydrogen project.	Alignment should be supported by targeted UK Government funding, ensuring that Welsh hydrogen projects have fair and equitable access to these opportunities. This will provide more incentive for renewable generators that hold a CfD to supply power to and contract with hydrogen producers.	
	Applicants to the hydrogen business model processes require clarity and certainty with respect to timelines, processes, eligibility and alignment.	**Provide greater certainty to industry throughout the HAR3 and HAR4 processes, and on HSBM and HTBM.** This will give hydrogen project developers and industry more confidence in the hydrogen market in the UK and will be more likely to back hydrogen projects.	**UK Government**
	Funding and timing certainty for HyLine Cymru and HyLine Gogledd to progress through FEED and into construction is crucial to Wales, without which, both the NEWID and SWIC clusters will be unlikely to secure hydrogen for hard-to-abate industry, risking deindustrialisation.	**Work with UK Government and WWU to secure funding for the development of Wales-based HyLine projects.** These projects initially need funding for FEED studies and are critical for Wales to provide hydrogen to industry in sufficient volumes to decarbonise.	**Welsh Government**
Shared narrative & strategy	Wales needs a clear narrative and strategy for hydrogen across the value chain and its use in industrial decarbonisation to promote growth, investment and skills.	**Develop a hydrogen strategy and roadmap for Wales.** This should include specific targets, and an accompanying skills plan. This will provide the hydrogen industry with a shared narrative and commitment to hydrogen from Welsh Government that they can use to drive forward their project plans.	**Welsh Government**

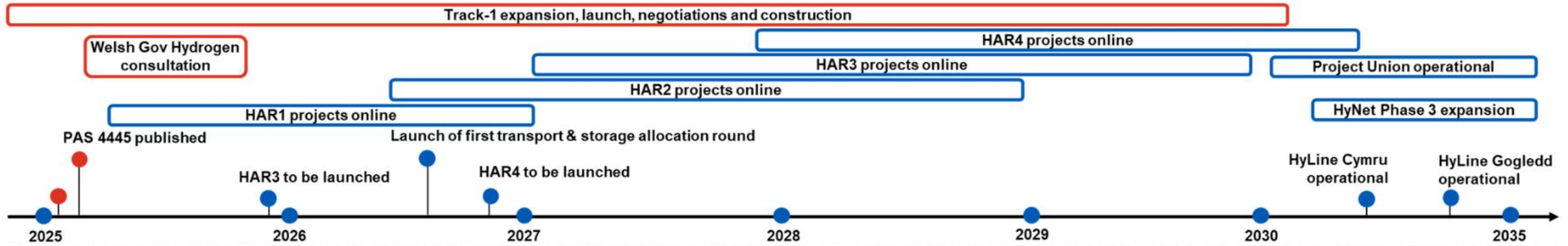
	There is an opportunity for increased advocacy for Welsh industry, clusters and projects, especially as the UK Government develops initiatives such as the British Industrial Competitiveness Scheme and Gas Shipper Obligation, amongst other strategic policies.	Work with UK Government to enable incoming national policy to meet the needs of Welsh industry (e.g. BICS and GSO). This is critical to support industry in Wales, while actively promoting Welsh industrial clusters to raise their national and international profiles.	Welsh Government
	There is an opportunity for Welsh Water and the future national water authority for Wales to develop strategic plans for the use of water for hydrogen production in future planning.	Work with Welsh Water and Ofwat/the future national water authority for Wales to understand the volumes and locations of water required for hydrogen production in Wales. These water needs for hydrogen should be included future strategic water plans. This will ready Wales for the transition to hydrogen.	Welsh Government
 **Policy, regulation & consenting**	Addressing grid connection delays, capacity constraints and affordability would accelerate hydrogen projects.	**Engage with NESO to influence and accelerate grid reform.** This will support hydrogen production projects in developing at pace and with greater electrical connection certainty.	**Welsh Government**
	The divergence between UK and EU regulation and policy creates divergence and could impact business competitiveness and certainty.	Collaborate with UK Government and work alongside the EU to link ETSs This should create a more liquid and stable carbon market, mitigate the impact of the EU CBAM, maintain industrial competitiveness and unlock cross-border trade opportunities.	Welsh Government

	Streamlining the hydrogen planning landscape and improving clarity and alignment between HSE and planning regulations, would provide greater certainty and help developers and accelerate project delivery.	Undertake a study to understand opportunities to streamline consenting and planning activities in Wales. This will support hydrogen developers to accelerate their plans with clarity.	Welsh Government
	Proactive community engagement and clear communication of local benefits can help overcome public opposition to hydrogen projects, easing planning approval and reducing delays.	Work with developers to develop best practice for community engagement and benefits. This will enable hydrogen projects to have better chance of receiving local support.	UK Government
 **Collaboration & engagement**	Welsh industrial clusters need connections to infrastructure in England to enable access to the volumes of hydrogen required to decarbonise industry. Collaboration and engagement are critical to enable this.	**Support NEWID to collaborate and co-operate with the North West Cluster to secure a connection to HyNet.** This is needed to secure the hydrogen required to decarbonise the cluster in North East Wales.	**Welsh Government**

6. Routemap and next steps

In Workshop 2, Arup worked with stakeholders prioritise actions and identify timeframes within which they should be undertaken. All the actions were seen as being required by 2030.

Actions were then mapped onto a timeline alongside planned UK Government policy critical to Wales, funding and projects from the literature review. From this, Arup has created a routemap to enable industrial decarbonisation using hydrogen in Wales (Figure 2).



Shared narrative & strategy

1. Develop a hydrogen strategy and roadmap for Wales with specific targets, and an accompanying skills plan.

2. Work with UK Government to enable incoming national policy to meet the needs of Welsh industry (e.g. BICS and GSO), while actively promoting Welsh industrial clusters to raise their national and international profiles.

3. Work with Welsh Water and the future national water authority for Wales to understand the volumes and locations of water required for hydrogen production in Wales and include water for hydrogen in future strategic water plans.

Business models & funding

4. Introduce more flexibility for offtakers under the HPBM and incentivise industrial fuel switching through targeted support mechanisms.

5. Align the HPBM with CfD-backed renewable generators

6. Provide greater certainty to industry throughout the HAR3 / HAR4 processes, including how the HSBM and HTBM will be implemented

Policy, regulation & consenting

7. Engage with NESO to influence and accelerate grid reform

8. Collaborate with UK Government and work alongside the EU to link ETS's

9. Undertake a study to understand opportunities to streamline consenting and planning activities in Wales

10. Work with developers to develop best practice for community engagement and maximise community benefits.

Collaboration & engagement

11. Support NEWID to engage with the North West Cluster to connect to HyNet

Arup recommends that the next step for Welsh Government is to deliver the actions outlined and engage with UK government to secure support. This should include consideration of resource requirements for Welsh Government's actions.

Arup also recommends that Welsh Government determines an engagement approach to build on the engagement through this project, and the recent hydrogen consultation. Continued engagement will help to inform and seek advice from stakeholders with respect to implementing the actions.

Welsh Government should seek to integrate the findings of both this report and the hydrogen consultation to inform policy development.

A.1 Literature review

A.1.1 Summary of key literature examined

This section summarises the key initial literature reviewed to provide broader context for the stakeholder engagement and analysis. The materials span both technological and commercial perspectives, covering UK and Welsh Government strategies, cluster plans, business models, and market insights relevant to hydrogen development in Wales.

Table 4: Documents reviewed during initial literature review

Technological Literature Reviewed	Commercial Literature Reviewed
• SWIC Cluster Plan • NEWID Cluster Plan • UK Government Hydrogen Strategy • Heat Strategy for Wales • Future Energy Grids for Wales • All publicly available Welsh LAEPs • Western Gateway hydrogen ecosystem map • Wales' fourth carbon budget - CCC • Hydrogen sponsor challenge - ANW • HAR1 and HAR2 projects • Project Union • HyLine (North and South) • Holyhead Hydrogen Hub • Hydrogen Development in Wales – Welsh Government	• Hydrogen Production Business Model • HAR1 and HAR2 projects • Hydrogen Transport Business Model • Hydrogen Storage Business Model • Hydrogen Transport and Storage: Minded to Positions • Hydrogen Transport and Storage Network Pathways • Hydrogen Strategy Update to the Market: December 2024 • Renewable UK: Splitting the Difference • OEUK Hydrogen Insights 2025 • UK Government Hydrogen Strategy • Scottish Government Hydrogen Action Plan • Wales' fourth carbon budget - CCC • SWIC Cluster Plan • NEWID Cluster Plan

A.1.2 Supplementary literature information

A.1.2.1 Policy landscape

A.1.2.1.1 Net Zero

This section discusses wider Net Zero policy context in the UK, and its relevance to hydrogen production, distribution, storage, and industrial decarbonisation in Wales.

In 2019, the UK became the first major economy to make a legally binding commitment to reaching net zero greenhouse gas emissions by 2050. This was a step change to the previous commitments of 80% reduction in greenhouse gas emissions and meant that for the first time, all sectors would need to fully decarbonise, including UK industry.

To support the legally binding net zero target, both UK and Welsh Government rely on independent advice from the Climate Change Committee (CCC), which produces a series of legally mandated carbon budgets[55]. These carbon budgets set legally binding limits on the total amount of greenhouse gases the UK can emit over five-year periods. Each budget is designed to ensure steady progress by requiring emissions reductions across all sectors, including energy, transport, buildings, and industry. The CCC provides detailed analysis and recommendations for how these targets can be met, considering technological feasibility, economic impact, and fairness.

The seventh carbon budget identifies the following five methods of decarbonisation which include hydrogen as part of 'low-carbon fuels'[56]:

- electricity
- low-carbon fuels and carbon capture, utilisation and storage (CCUS)
- nature
- engineered removals
- demand

A.1.2.1.2 Industrial Decarbonisation

This section discusses industrial decarbonisation policy and its relevance to hydrogen production, distribution and use in industry in Wales. It first covers key aspects of UK decarbonisation policy, then key aspects of Welsh and EU decarbonisation policy. In each section, brief summaries of the relevant policies are provided.

UK Policy

In 2025, the UK Government published the UK's Modern Industrial Strategy 2025[2]. This document outlined a 10-year vision to drive sustainable economic growth by fostering innovation, investment, and productivity across key sectors. A central pillar of this strategy is industrial decarbonisation, particularly through the Clean Energy Industries Sector Plan. It committed to at least doubling current investment levels in clean technologies by 2035,

[55] CCC. (2025). *Carbon budgets*. Retrieved from https://www.theccc.org.uk/publicationtype/report/carbon-budget/

[56] CCC. (2025). *The Seventh Carbon Budget*. Retrieved from https://www.theccc.org.uk/publication/the-seventh-carbon-budget/

targeting areas such as carbon capture, hydrogen, nuclear fusion, and offshore wind. The strategy emphasised creating high-quality jobs in industrial heartlands and coastal communities, aiming to position the UK as a global leader in low-carbon manufacturing and exports. It also stressed the importance of long-term certainty for businesses, public-private collaboration, and regional investment to ensure a just and inclusive transition to net zero.

The UK government has committed to publishing a new Industrial Decarbonisation Strategy by 2026 to support the transition towards net zero.

Welsh Policy

Future energy grid for Wales (FEW)[57] outlined a strategic vision for transforming Wales' energy infrastructure to achieve Net Zero emissions by 2050. The report employed whole-system modelling to explore how electricity and gas networks must evolve to support decarbonisation across power, heat, and transport sectors. FEW identified the key implications for electricity and gas network operators and steps needed to develop energy networks in Wales and suggests recommendations for Welsh government to take forward.

With respect to hydrogen, the FEW report states that hydrogen will be required to replace fossil fuels, alongside technologies such as electrification, CCUS and biofuels. The report states that the scale and production method of hydrogen will impact the whole energy system, particularly increasing electricity demand to produce green hydrogen. The report also outlines that the quantity, and production methods, of hydrogen is not fully understood and will impact the electricity, natural gas and hydrogen networks in Wales. A key insight in the report is that a hydrogen transmission system could be required in both South West and North East Wales by the early 2030s to provide supply of hydrogen to industries, potentially from areas of Wales with lower grid constraints or large renewables projects.

Wales's fourth Carbon Budget[58] published in May 2025, sets out a legally binding emissions cap for the period 2031 to 2035. It recommends large emissions cuts in energy, transport, buildings, industry, and agriculture, alongside increased carbon removals through land use and forestry. While the pathway suggested requires significant investment, the report argues that the long-term economic, environmental, and social benefits far outweigh the costs. It also highlights the need for strong leadership, policy clarity, and collaboration across all levels of government to ensure Wales remains on track to meet its climate goals.

The fourth carbon budget identifies hydrogen as a critical low-carbon fuel, particularly for sectors that are hard to electrify, such as heavy industry and certain transport applications. The CCC recommends that Wales develop a clear hydrogen strategy, including production, infrastructure, and end-use deployment, to support industrial clusters and enable fuel switching from fossil fuels. The report stresses the importance of early investment and policy certainty to drive innovation and competitiveness, especially in South Wales's industrial heartlands. The CCC also calls for coordinated action between the Welsh and UK governments to ensure that Welsh industries are not left behind in the transition and can benefit from UK-wide funding and infrastructure initiatives.

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[57] Welsh Government. (2023). *Future energy grids for Wales: reports.* Retrieved from https://www.gov.wales/future-energy-grids-wales-reports

[58] CCC. (2025). *Wales' Fourth Carbon Budget*. Retrieved from https://www.theccc.org.uk/publication/wales-fourth-carbon-budget/

The Heat strategy for Wales[59] outlines a comprehensive roadmap to achieving net zero heat by 2050, including decarbonising industrial heat. For industry, the strategy recognises the complexity of decarbonising high energy demands of industrial processes, particularly in sectors like steel, chemicals, and manufacturing. It commits to supporting innovation and infrastructure development to enable a shift away from fossil fuels. Hydrogen is highlighted as a key potential solution for high-temperature industrial heat, but its deployment is contingent on the outcomes of hydrogen trials for fuel switching and strategic decisions from UK Government. In the report, Welsh Gov outlines ambitions to build robust evidence and align with UK hydrogen and industrial strategies, while also advocating for regional investment and pilot projects to test hydrogen's viability in Welsh industrial contexts

Local Area Energy Plans (LAEPs) are strategic, data-driven frameworks designed to guide the decarbonisation of energy systems on a local authority level. They assess current and future energy needs across sectors such as buildings, transport, and industry, and identify the most effective pathways to achieve net-zero emissions. Welsh Government funded the development of these plans for every local authority in Wales, supporting regional bodies to lead the process.

Whilst not all LAEPs are publicly available at the time of writing, each has outlined plans to decarbonise the entire local authority areas, including the industries within them. Hydrogen is considered in most LAEPs, with higher future required demands estimated in areas with more industry.

The North Wales Growth Deal is an initiative led by Ambition North Wales (ANW), the regional body for North Wales, which aims to boost the region's economy through strategic investment in innovation, infrastructure, and low-carbon technologies[60]. In 2020, UK and Welsh Government committed £240million, to be delivered over 15 years, as part of the Growth Deal.

One of its flagship projects within the Growth Deal is the Hydrogen Sponsor Challenge [61], aiming to support establishing a hydrogen economy in the region. With up to £11.2million in capital funding available, the challenge invites organisations to lead the development of a hydrogen hub that encompasses both production and end-use. This initiative is designed to stimulate demand for low-carbon hydrogen, support the transition away from fossil fuels, and deliver tangible benefits such as job creation, carbon savings, and inward investment

Also, as part of the Growth Deal, ANW has launched a £24.6million Clean Energy Fund[62]. The fund is designed to support businesses and voluntary organisations in developing renewable energy, energy efficiency, and decarbonisation projects. This includes manufacturing and supply chain opportunities. The fund comprises two separate

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[59] Welsh Government. (2024). *Heat strategy for Wales*. Retrieved from https://www.gov.wales/heat-strategy-wales

[60] ANW. (2025). *Growth Deal*. Retrieved from https://ambitionnorth.wales/economic-well-being/growth-deal/

[61] ANW. (n.d.). *Hydrogen Sponsor Challenge*. Retrieved from https://ambitionnorth.wales/media/msbdj0hb/hydrogen-sponsor-challenge-brochure.pdf

[62] ANW. (2025). North Wales Clean Energy Fund. Retrieved from https://ambitionnorth.wales/low-carbon-energy/clean-energy-fund/

sub-fund, targeting the private and voluntary sectors.

The Holyhead Hydrogen Hub is a project which was earmarked for £3.8m of funding from ANW to develop a 1MW electrolyser, with plans to increase this to 5MW or 10MW in the future, at Parc Cybi, Holyhead.[63] The hydrogen is planned to be used for transport, industry, and Non-Road Mobile Machinery (NRMM).

The Mid Wales Energy Strategy (2020) was developed by Growing Mid Wales, a regional partnership covering Ceredigion and Powys local authority areas[64]. The strategy highlights hydrogen as a promising future energy source, particularly for decarbonising transport, supporting energy storage, and serving industrial heat needs where electrification is challenging. While hydrogen infrastructure in the region is still in its infancy, the strategy calls for further exploration through feasibility studies and pilot projects. Regarding industry, the strategy acknowledges that Mid Wales is not heavily industrialised but sees opportunities to decarbonise light manufacturing and rural enterprises through energy efficiency, electrification, and renewable energy adoption. It also emphasises the importance of developing local supply chains and green skills to support a low-carbon industrial transition.

EU Policy

The wider landscape, outside of Wales and the UK is important to consider and understand – not only for the export opportunities that it offers to domestic businesses, but also because many of these businesses operate internationally and may be influenced by differences in regulatory, policy, and investment environments when deciding where to locate and invest. The particular market of interest is that of the EU, who account for more than 40% of goods trade for UK exporters[65].

Currently the UK and EU have their own Emissions Trading Systems (ETS) and carbon markets. An ETS is a cap-and-trade system, whereby government sets limits of the total GHG emissions allowed from specific sectors. While participants must hold allowances equivalent to their emissions, they are able to buy or sell (auction) these, creating a carbon market with a fluctuating carbon price depending on supply and demand[7]. Over time, the cap shrinks in size and fewer allowances are auctioned annually. This pushes up prices, making it more cost-effective to decarbonise than continue to pollute. The UK was the first country in the world to pilot a national ETS in 2002, this became the basis of the EU ETS, established in 2005, in which the UK participated until Brexit. However, post-Brexit, a new standalone UK ETS was implemented from 2021, with a commitment to 'seriously consider' linking the two schemes in the future. The UK ETS is roughly 10 times smaller

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[63] Menter Mon. (2025). Holyhead Hydrogen Hub. Retrieved from https://www.mentermon.com/en/prosiectau/hwb-hydrogen/#:~:text=North%20Wales%20is%20becoming%20an,term%20benefit%20for%20our%20communities.

[64] Growing Mid Wales. (2020). *Mid Wales Energy Strategy*. Retrieved from https://www.gov.wales/sites/default/files/publications/2021-11/regional-energy-strategy-mid-wales.pdf.

[65] Energy Advice Hub. (2025). *The UK-EU ETS agreement: What it is and how it will affect UK businesses*. Retrieved from https://energyadvicehub.org/the-uk-eu-ets-agreement-what-it-is-and-how-it-will-affect-uk-businesses/

than the EU ETS which means it suffers from low liquidity making the UKs carbon price more volatile[45].

The EU's Carbon Border Adjustment Mechanism (CBAM) officially took effect on 01 October 2023. It is designed to uphold the EU's climate ambitions by decarbonising imported goods. The CBAM specifically targets imports that are both carbon-intensive and highly susceptible to carbon leakage, including products such as cement, iron and steel, aluminium, fertilisers, electricity, and Donehydrogen. Under this mechanism, imports from countries with lower carbon pricing will face higher levies, thereby incentivising cleaner industrial production methods and promoting a level playing field for EU industries.

A.1.2.1.3 Hydrogen

This section provides details on the UK hydrogen policy landscape. It firstly discusses the strategies, targets and ambitions that the UK has set, including carbon capture and storage (CCS) policy relevant to hydrogen, and then covers the financial and commercial support for projects.

The UK has several policies that support the use of hydrogen for industrial decarbonisation. This is primarily outlined in the UK Hydrogen Strategy and the UK's Modern Industrial Strategy.

Strategy, targets and ambitions

UK Government published the UK Hydrogen Strategy in 2021[24] as a comprehensive plan to develop a low-carbon hydrogen economy. The strategy outlines an ambition to make the UK a *"global leader on hydrogen"* with 5 GW of low-carbon hydrogen production capacity by 2030. The strategy outlines that at the time there were very few low-carbon hydrogen production projects currently operational in the UK but predicted that hydrogen will play a significant role in the future energy mix, making up an estimated 20 to 35% of total energy consumption in 2050.

The UK ambitions for hydrogen were later updated as part of the British Energy Security Strategy in 2022. This strategy doubled the previous UK ambition, as set out in the UK Hydrogen Strategy, to 10 GW of low-carbon hydrogen production by 2030, with at least half to come from electrolysis[25]. This strategy also outlined support for hydrogen blending with natural gas, establishing a certification scheme and running allocation rounds - all of which was later established[26] [27].

A suite of support for the market was also announced as part of the UK Hydrogen Strategy to stimulate both production and demand and as part of the 2035 Delivery Plan.

To support the production ambitions in particular, the UK Government introduced the Net Zero Hydrogen Fund (NZHF) (waves 1 & 2) to provide up to £240million of CAPEX and DEVEX for low carbon hydrogen projects. Alongside this fund, the UK Government introduced the Hydrogen Production Business Model (HPBM, formerly known as the Hydrogen Business Model (HBM)), designed to provide 15 years of support to projects that applied to receive CAPEX funding from the NZHF but also required ongoing support from the HPBM. More information is provided on the HPBM below.

The UK Hydrogen Strategy also outlined clear support for fuel switching with hydrogen in industry, particularly in the hard to decarbonise sectors, as well as feedstock in some instances for example for the chemicals sector. As part of the strategy the government committed to undertaking the Industrial Fuel Switching (IFS) competition.

The IFS competition launched in 2021 alongside the Low Carbon Hydrogen Supply (HS) innovation programme as part of the government's Energy Innovation Programme (EIP)[66]. The £21million IFS competition aimed to stimulate early investment in, and development of, fuel switching processes and technologies. The £33million HS programme sought to develop, demonstrate and reduce the cost of low carbon bulk hydrogen solutions (production, storage and supply).

An independent review of the IFS and HS programme was published in 2025 and found that while the competition stimulated innovation, widespread adoption of fuel switching technologies was limited by high costs of switching to hydrogen or electricity and a lack of hydrogen infrastructure[66]. From a Welsh perspective, Dolphyn received funding from the HS and HyNet (which looks to span into Wales from England) received funding from both the IFS and HS.

Recognising the changes in the market and landscape evolution since 2021, the UK Government has committed to publishing an updated Hydrogen Strategy in Autumn 2025 and its most recent update to market (July 2025) reiterates that the UK Government is *"serious about hydrogen".*

CCUS for hydrogen

Carbon capture, usage and storage (CCUS) is, in itself, a method of industrial decarbonisation through capturing and storing carbon emissions, which would otherwise be emitted to the atmosphere. CCUS should be considered when discussing low-carbon hydrogen as it is a common a pathway to produce low-carbon, 'blue', hydrogen by capturing carbon emissions from fossil-based processes such as steam methane reforming.

The UK Government's Carbon Capture, Usage and Storage Cluster Sequencing programme is a phased approach to deploying CCUS infrastructure in key industrial regions. It prioritises clusters where carbon transport and storage networks can be shared and developed efficiently. The first phase (Track-1) includes HyNet (in the North West of England and North East of Wales) and East Coast (Teesside) Clusters, while the second phase (Track-2), announced in 2025, supports the Acorn (Scotland) and Viking (Humber region) Clusters.

Financial and commercial support

As part of the UK Hydrogen Strategy and developments since its publication, the UK Government has delivered and committed to various forms of financial and commercial support for hydrogen projects across production, transport, and storage.

The policy and funding support landscape surrounding the growing adoption of hydrogen for use in industry is complex and continually developing. Through this literature review we have identified the main streams of public and private support for the growth of hydrogen and its use.

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[66] DESNZ. (2025). *Evaluation of the Industrial fuel switching and hydrogen supply innovation programmes*. Retrieved from https://assets.publishing.service.gov.uk/media/68400dfb1d85c6606009ccbb/IFS-HS-evaluation-report.pdf

Major public support is delivered through hydrogen business models, which cover the major parts of the hydrogen value chain: production, storage and transport. Private investment streams have also been identified and are outlined below.

Hydrogen Production Business Model

The first round of the Hydrogen Production Business Model (HPBM) was announced as part of the UK Hydrogen Strategy and is the most advanced of the UK's hydrogen business models to date. It provides revenue support to incentivise investment in new low carbon hydrogen production by making it a price competitive decarbonisation option. It does this by providing a subsidy to producers to cover the gap between the levelised cost of hydrogen and the price that the producer can achieve - this is explained in further detail in Figure 5.

The HPBM should help to stimulate demand because the subsidy paid to producers will enable them to sell hydrogen at a price that is more affordable for consumers.

The HPBM is delivered through the Low Carbon Hydrogen Agreement (LCHA), a private law contract signed between a hydrogen producer and a government counterparty, the Low Carbon Contracts Company (LCCC). The draft terms of the LCHA were released in August 2023, and by January 2024, the LCCC was formally appointed under the Energy Act 2023 to manage revenue support contracts for low carbon hydrogen production.

The HPBM supports a range of hydrogen production pathways. For production routes that do not rely on CCUS, such as electrolytic hydrogen, is provided through HARs. HARs are specifically designed to allocate revenue support through the HPBM to non-CCUS hydrogen production facilities across the UK. Conversely, support for CCUS-enabled production is provided through the CCUS Cluster Sequencing Process.

Revenue Support Through the HPBM

The LCHA is largely based on the standard T&Cs underpinning the Contract for Difference (CfD) regime in the UK, used largely across the UK renewables sector. This 'variable premium' mechanism provides price certainty for producers. Producers are paid a premium for low carbon hydrogen produced and sold – determined by the difference between the Strike Price and the Reference Price as well as the qualifying volume sold[14].

To receive funding, producers must produce hydrogen that meets the Low Carbon Hydrogen Standard (LCHS) in force at the time of the agreement and sell it to qualifying off-takers. These agreements are long-term agreements that will run over a 15-year period.

- **Strike Price:** The level at which a producer can cover production costs and secure a predefined return on investment, aimed at providing revenue stability.
- **Reference Price:** Intended to reflect the hydrogen market price and, in the absence of a market benchmark, is the higher of the Natural Gas Floor Price and the Achieved Sales Price.
- **Difference Payments:** Producers are paid a premium for low carbon hydrogen produced and sold – determined by the difference between the Strike Price and the Reference Price and the qualifying volume sold.
  - If the strike price is higher than the reference price, the LCCC pays the difference to the producer.
  - If the reference price exceeds the strike price, the producer pays the difference to the LCCC.

- **Price Discovery Incentive:** Producers receive 10% of the difference between the lower of the Reference Price and the Strike Price, and the Floor Price, to incentivise sales prices above the gas price.
- **Sliding Scale Top-Up Amount:** If the total volume of hydrogen sold falls below 50% of the forecast reference volume due to demand-related issues, the producer receives a top-up for each qualifying unit sold. This support is not available if the reduction in sales is due to producer fault or facility unavailability.

Hydrogen Allocation Rounds

The HARs are the primary delivery mechanism for the HPBM for hydrogen production. To date there have been two rounds of the HAR process:

- **Progress of Round 1:**
  - Launched in July 2022, HAR1 had 41 applications and awarded contracts to 11 projects with a combined capacity of 125MW against a target of 250MW. These contracts were agreed at a weighted average strike price of £241/MWh.
  - The LCCC has issued LCHAs to the first six projects.
  - Over £90million from the Net Zero Hydrogen Fund (Strand 3) will support their build-out, pending contract finalisation.
  - Contracts for the remaining projects are expected in 2025, with projects set to become operational the same year[31].
- **Progress of Round 2:**
  - Launched in December 2023, HAR2 has a target to support 875MW of capacity.
  - HAR2 was oversubscribed, receiving 87 applications totalling over 2.8GW of potential production capacity for delivery between 2026 and 2029.
  - The government published its shortlist of 27 electrolytic projects across England, Scotland, and Wales that were invited to the cost due diligence stage of the process[32].
  - The high level of interest signals that the UK's hydrogen policy and regulatory framework offers an attractive investment opportunity.

The UK Government has committed to developing plans for HAR3 to align with evolving priorities, with a launch *"by 2026".* An ongoing market engagement exercise will gather industry feedback on its design and delivery.

In 2025, a broader review will assess the structure of post-HAR4 rounds, potentially shifting to an independent allocation body and a competitive, price-based model. This review will consider market conditions and lessons from earlier rounds, to ensure industry has clear foresight before any changes are introduced[67].

There were two successful HAR1 applications in Wales, and three Welsh HAR2 applications have been shortlisted.

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[67] DESNZ. (2024). *Hydrogen Strategy Update to the Market: December 2024*. Retrieved from GOV.UK: https://www.gov.uk/government/publications/hydrogen-strategy-update-to-the-market-december-2024

Hydrogen Transport, and Hydrogen Storage Business Model

UK Government has committed over £500million through Spending Review 2025 for the development and operation of the UK's first regional hydrogen transport and storage network by 2031. This will be underpinned by both the transport and storage business models which are currently in development and are described below.

The Hydrogen Storage Business Model (HSBM) aims to ensure that hydrogen storage infrastructure is available to meet the needs of users in the emerging hydrogen economy by addressing imbalances in hydrogen production and demand. The business model aims to secure timely investment in storage while maintaining flexibility to adapt to changes in the hydrogen market[68].

A core element of the proposed business model is a revenue 'floor' designed to mitigate demand risk, which includes both price risk and volume risk, identified as a significant barrier to investment. In addition to the revenue floor, the model includes an incentive for storage providers to maximise sales to users and a mechanism that could give the subsidy provider a potential share of the 'upside'. Initial support will focus on geological storage due to its large capacity and energy security benefits, though above-ground storage may also be supported if it faces similar challenges.

The model will be delivered via 15-year private contracts between storage providers and a subsidy provider, covering the entire UK. Support will be bilaterally negotiated with the DESNZ, not through competitive bidding, due to the limited number of early projects the UK Government expects to see. Strategic planning will play a role in how support is allocated, with coordination expected with the HTBM to ensure cohesive network development.

Work is continuing on the detailed design of the HSBM and the UK's Modern Industrial Strategy Clean Energy Industries Sector Plan details that the first round is planned for 2026 and is expected to support up to two large-scale projects by 2030[2]. Ongoing work will refine the model and assess future transport and storage needs.

The Hydrogen Transport Business Model (HTBM) aims to develop the necessary infrastructure to connect hydrogen producers, consumers, and storage, supporting the UK's goal of up to 10GW of low-carbon hydrogen production by 2030[68].

The government's minded-to high-level design for the HTBM is a Regulated Asset Base (RAB). A RAB model is considered well-supported for a growth phase due to its familiarity to potential investors and its ability to de-risk investment. It offers flexibility to adapt to the market's transition from a nascent to a mature state. Alongside the RAB, an external subsidy mechanism is proposed to keep user charges affordable while ensuring fair returns for transport providers. However, funding details are still undecided.

The government recognises the interplay between transport and storage. To ensure the development of hydrogen networks in a cohesive way, a coordinated allocation process between the HTBM and the HSBM is envisaged. Decisions regarding which regional pipelines to support through the HTBM will need to be coordinated with decisions on storage projects under the HSBM. Strategic planning will play a role in how support is allocated for both models.

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[68] DESNZ. (2023). *Hydrogen transport and storage infrastructure: minded to positions*. Retrieved from GOV.UK: https://www.gov.uk/government/consultations/proposals-for-hydrogen-transport-and-storage-business-models

Hydrogen policy in Wales

This section describes Wales' current hydrogen policy.

The UK Hydrogen Strategy[24] highlighted Wales's potential for low carbon hydrogen production and use. It states

"Wales has significant opportunities for low carbon hydrogen production and use. Its offshore wind and tidal and wave power potential, strong infrastructure networks and ports, research and development strengths, skills base, and readily available internal markets provide a platform for deployment of hydrogen and fuel cell technologies under a favourable policy environment."

Although Wales does not have a formal national hydrogen strategy of its own, Welsh Government did undertake a baseline study of hydrogen in Wales and produced a pathway forward in 2020. Welsh Government has also held two hydrogen consultations in recent years to inform the direction of travel.

Most recently Welsh Government held a Hydrogen Policy consultation with a close date of 30 May 2025[69]. The purpose of this consultation was to receive stakeholder feedback on Welsh Government's preferred policy position for hydrogen.

Before then, in January 2021, Welsh Government issued a pair of reports, one to assess the baseline for hydrogen activity in Wales[70] and another to provide a pathway to develop hydrogen in Wales[71].

The baselining report mapped industrial production, energy applications, academic research, and planned projects. It highlighted Wales's potential to become a key player in the hydrogen economy, leveraging its renewable energy resources, industrial base, and strategic partnerships.

The pathway and next steps report looked to inform activities that will take place in the short term (to 2025)[71]. Ten key objectives were presented as outlined in Figure 3.5. These include ambitions to establish a 10 MW hydrogen production site in Wales by 2023/24 and to plan for large-scale (100 MW+) low-carbon hydrogen production sites.

The document is not (and was not intended to be) a comprehensive strategy for hydrogen in Wales, rather it sought to define a set of no regrets actions to position Wales to take advantage of the range of benefits that increased uptake of hydrogen can bring[72].

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[69] Welsh Government. (2025). *Hydrogen policy.* Retrieved from https://www.gov.wales/hydrogen-policy-html

[70] Welsh Government. (2020). *Baselining report into hydrogen activities and expertise in Wales*. Retrieved from https://www.gov.wales/sites/default/files/consultations/2021-01/baselining-report-hydrogen-development-in-wales.pdf

[71] Welsh Government. (2020). *A pathway and next steps for developing the hydrogen energy*. Retrieved from https://www.gov.wales/sites/default/files/consultations/2021-01/hydrogen-in-wales-consultation.pdf

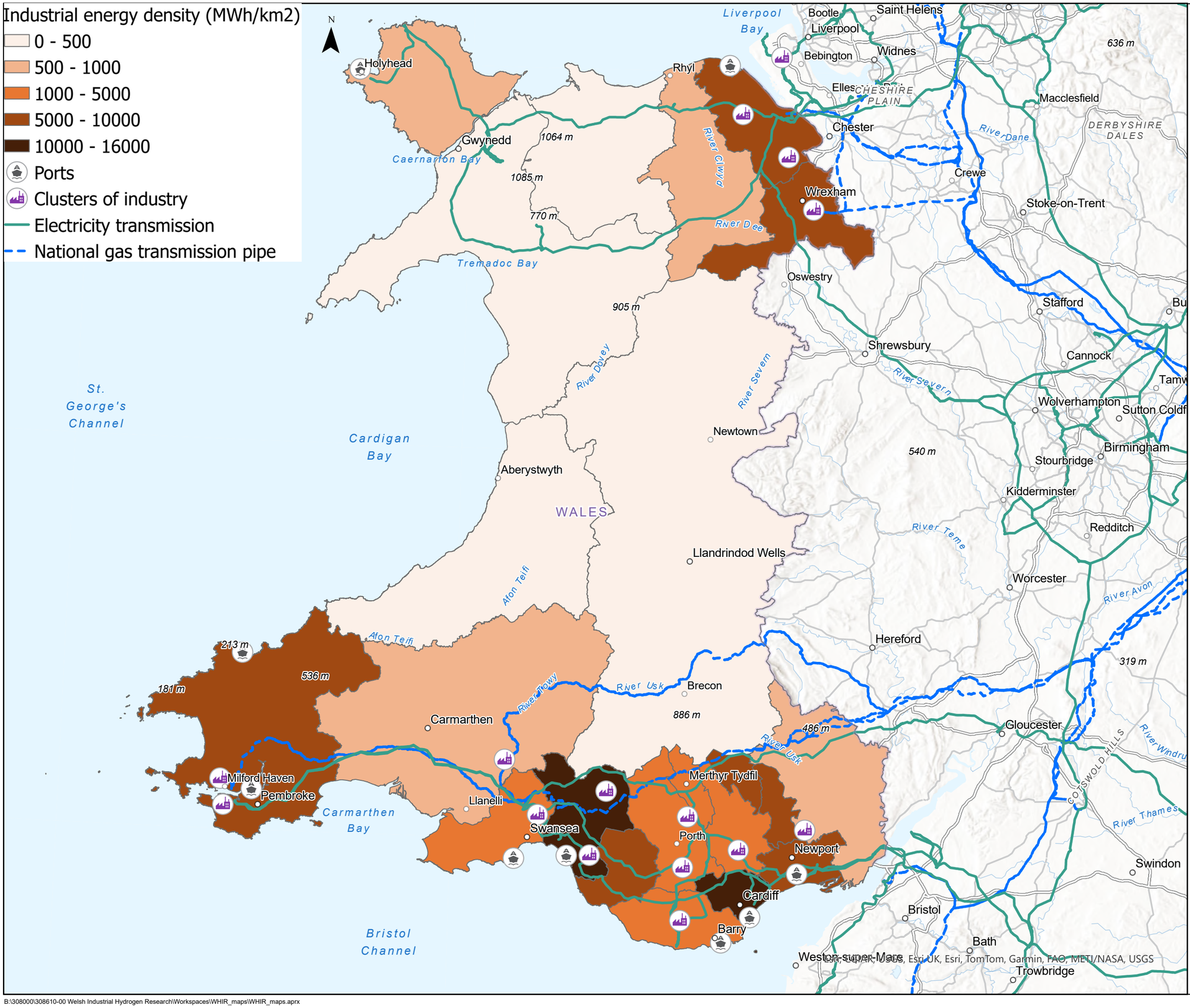
[72] Welsh Government. (2022). *Consultation – summary of response: A pathway and next steps for developing the hydrogen energy sector in Wales.* Retrieved from https://www.gov.wales/sites/default/files/consultations/2022-06/hydrogen-in-wales-consultation-response_0.pdf

A.2 Geospatial analysis

The following pages provide the geospatial analysis undertaken and maps produced of the existing and planned energy infrastructure in Wales.

Maps are provided of Wales' current infrastructure, followed by a more detailed look at North and South Wales separately.

Maps are also provided of the planned energy infrastructure projects in Wales, followed by a more detailed look at North and South Wales separately.



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Client

Welsh Government

Project Name

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Drawing Title

Wales Current industrial and energy system

Scale at A3

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Role

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Suitability

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Project Number

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Drawing Number

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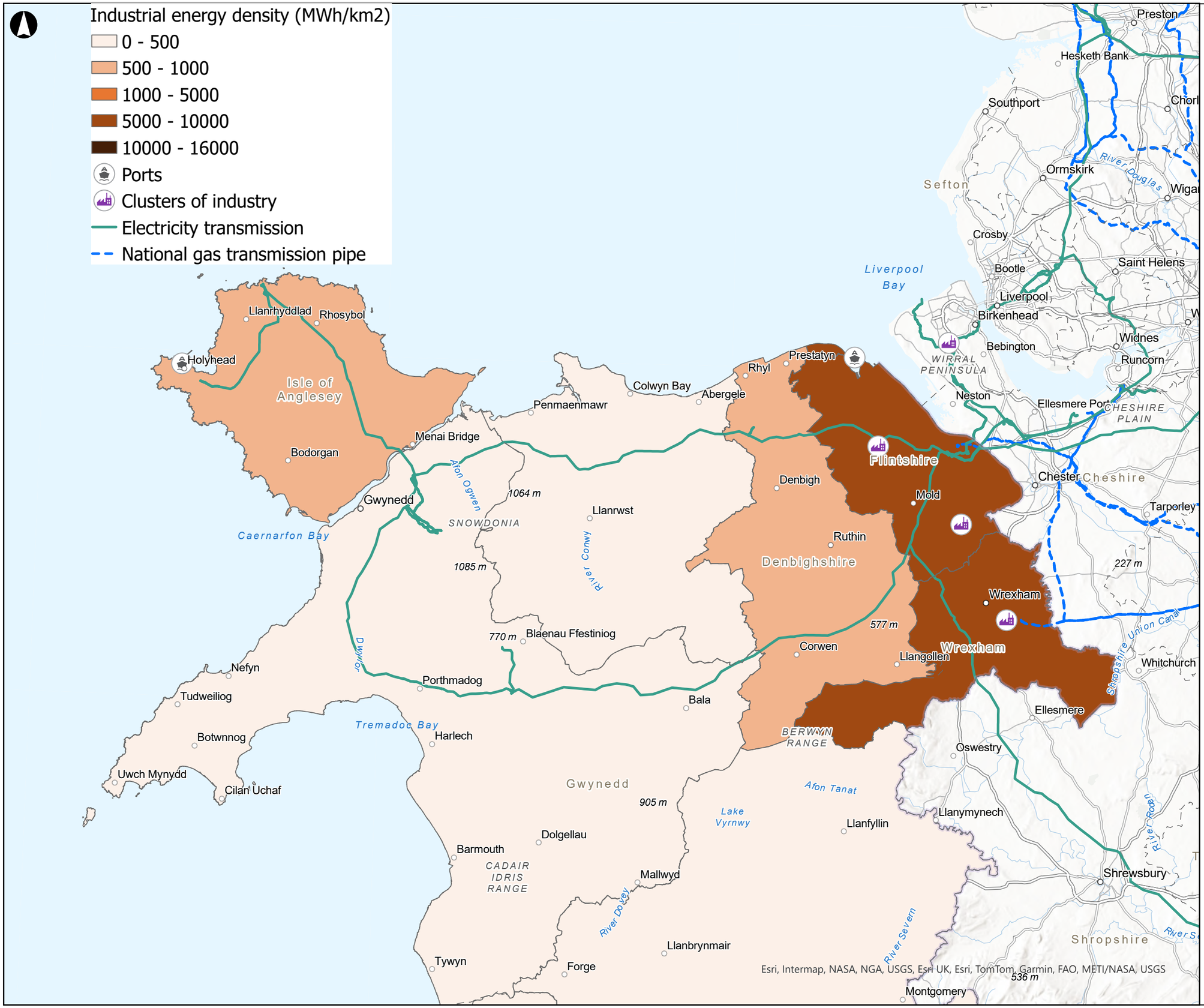

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Project Name

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Drawing Title

North Wales Current industrial and energy system

Scale at A3

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Role

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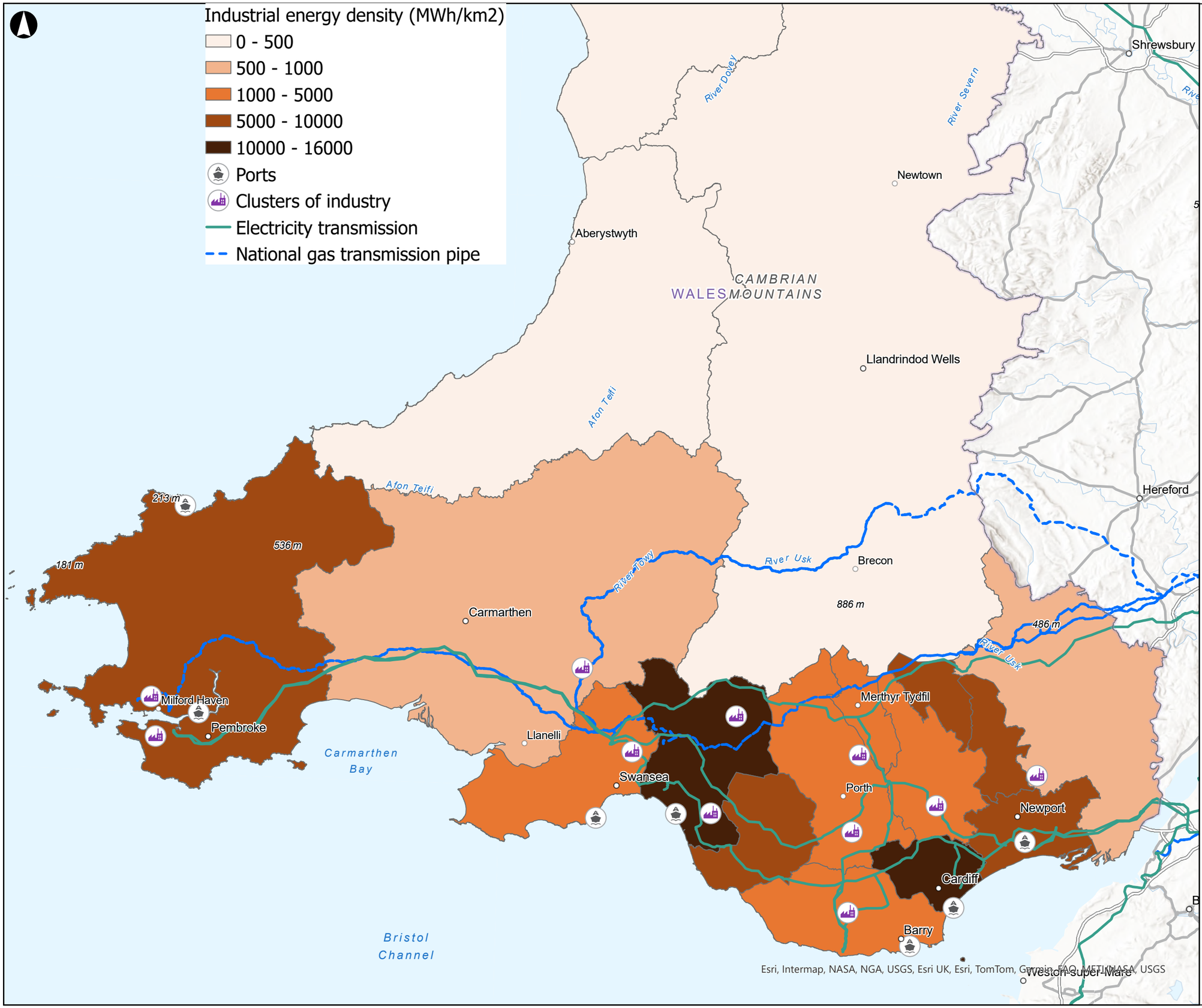

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Project Name

Welsh Industrial Hydrogen Research

Drawing Title

South Wales Current industrial and energy system

Scale at A3

1:600,000

Role

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Suitability

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Project Number

Rev **P01**

Drawing Number

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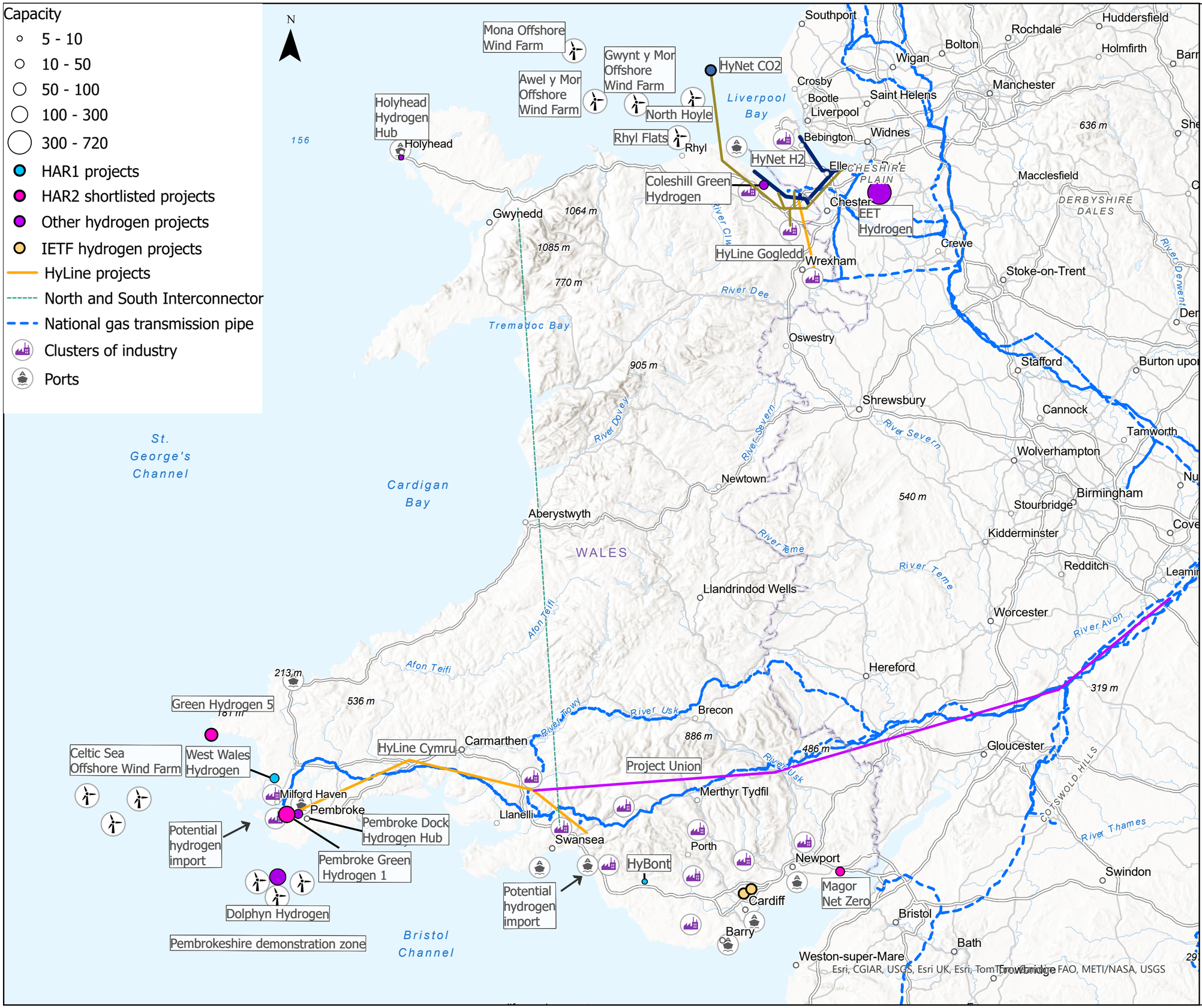

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Drawing Title

Wales planned and future energy system and projects

Scale at A3

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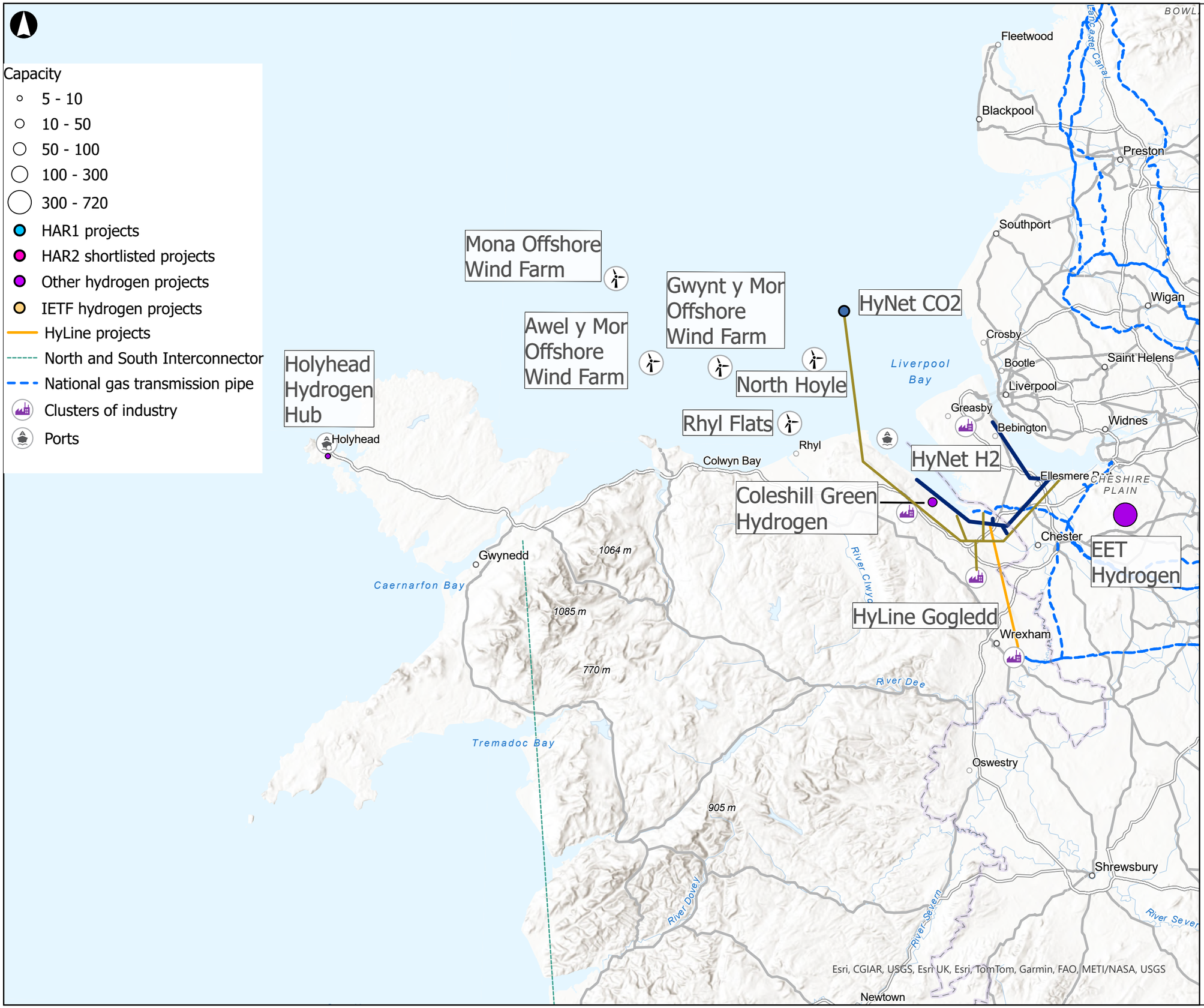

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Project Name

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Drawing Title

North Wales planned and future energy system and projects

Scale at A3

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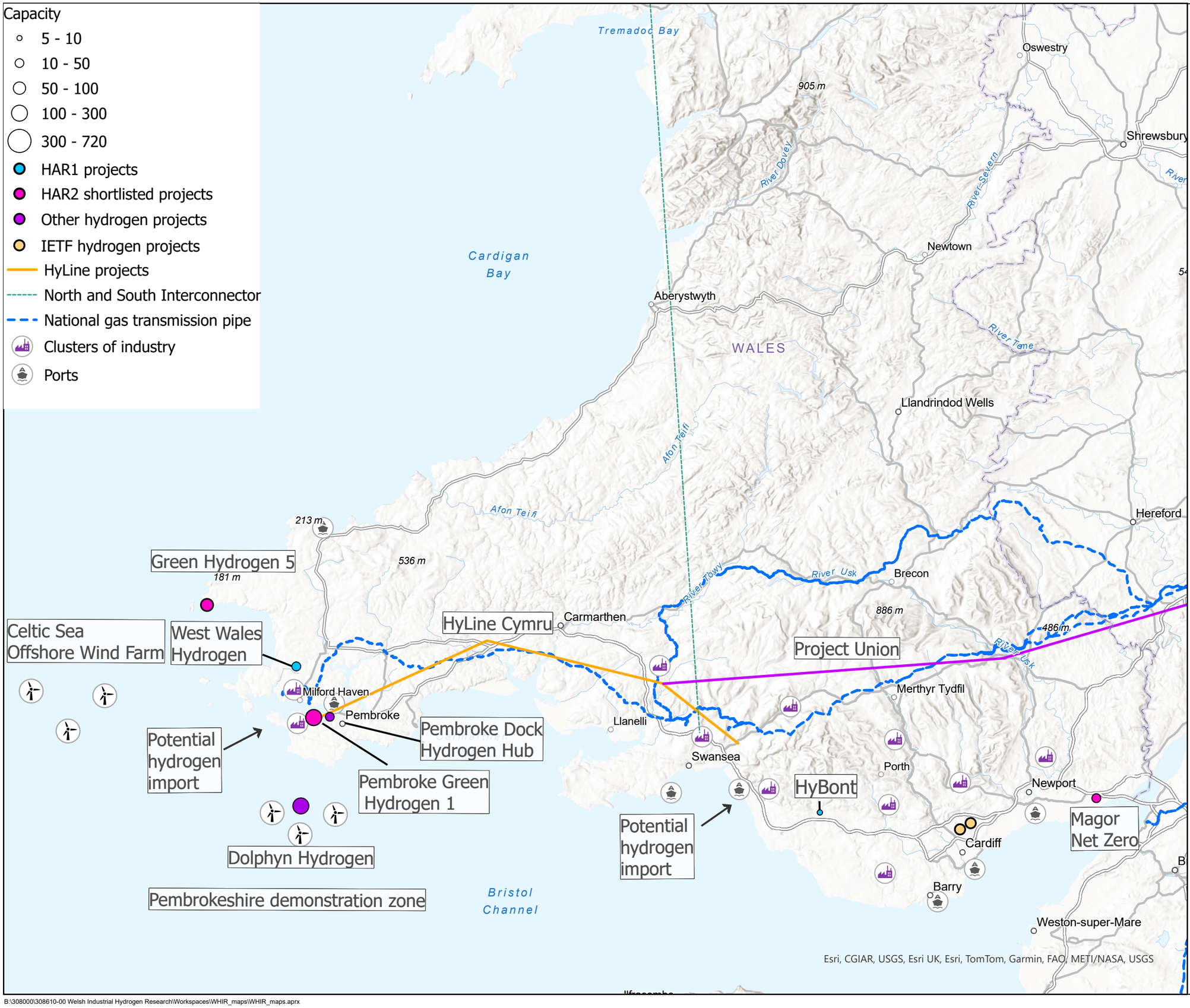

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Drawing Title

South Wales planned and future energy system and projects

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Role

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A.3 Stakeholder engagement approach and findings

A.3.1 Stakeholder planning and mapping

This section presents the initial stakeholder mapping axes used by Arup and developed in collaboration with the Welsh Government. It used an influence–interest matrix to categorise stakeholders as high, medium, or low priority to guide participant selection and ensure balanced representation across the hydrogen value chain.

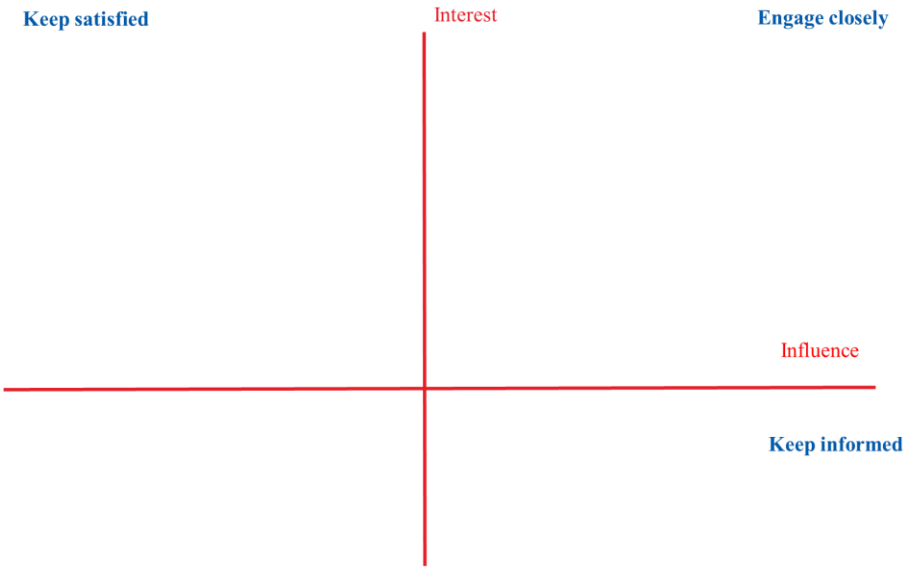

Figure 4: Influence-Interest matrix used for stakeholder mapping

A.3.2 Workshop 1: action planning

This section outlines the agenda and descriptions of each item from the first stakeholder workshop, which focussed on engaging key stakeholders in testing and validating the findings of the literature review, identifying missing evidence and confirming the key challenges and opportunities for hydrogen delivery in Wales.

Table 5: Workshop 1 agenda

No.	Item	Description
1	Welcome	Welcome to workshop and housekeeping
2	Introduction to the project & objectives of the workshop	Outline project context, aims and outputs and introduce the aims of the workshop
3	Technological overview (landscape & maps)	Present literature reviewed and findings re. the current Welsh hydrogen ecosystem

4	Technological activity (opportunities, barriers and actions)	Present identified opportunities, barriers and actions, invite challenge from stakeholders
5	Commercial overview (landscape)	Present literature reviewed and findings re. the current commercial hydrogen ecosystem
6	Commercial activity (opportunities, barriers and actions)	Present identified opportunities, barriers and actions, invite challenge from stakeholders
7	Next steps	Outline the next phases of the project

A.3.3 Workshop 2: Routemap

This section provides the agenda and item descriptions from the second stakeholder workshop, which was focussed on producing an action routemap that was wholly informed by the literature review, workshops and stakeholder interviews. The action prioritisation matrix used by participants to assess the urgency and impact of proposed actions is also included below.

Table 6: Workshop 2 agenda

No.	Item	Description
1	Welcome	Welcome to workshop and housekeeping
2	Recap of the project	Re-visit project context, aims and outputs
3	Objectives of the workshop	Introduce the aims of the workshop
4	Challenges and actions (technical recap & action prioritisation)	Recap updated challenges and actions, then allow stakeholders to prioritise these in Miro
5	Challenges and actions (commercial recap & action prioritisation)	Recap updated challenges and actions, then allow stakeholders to prioritise these in Miro
6	Next steps	Outline the final phases of the project

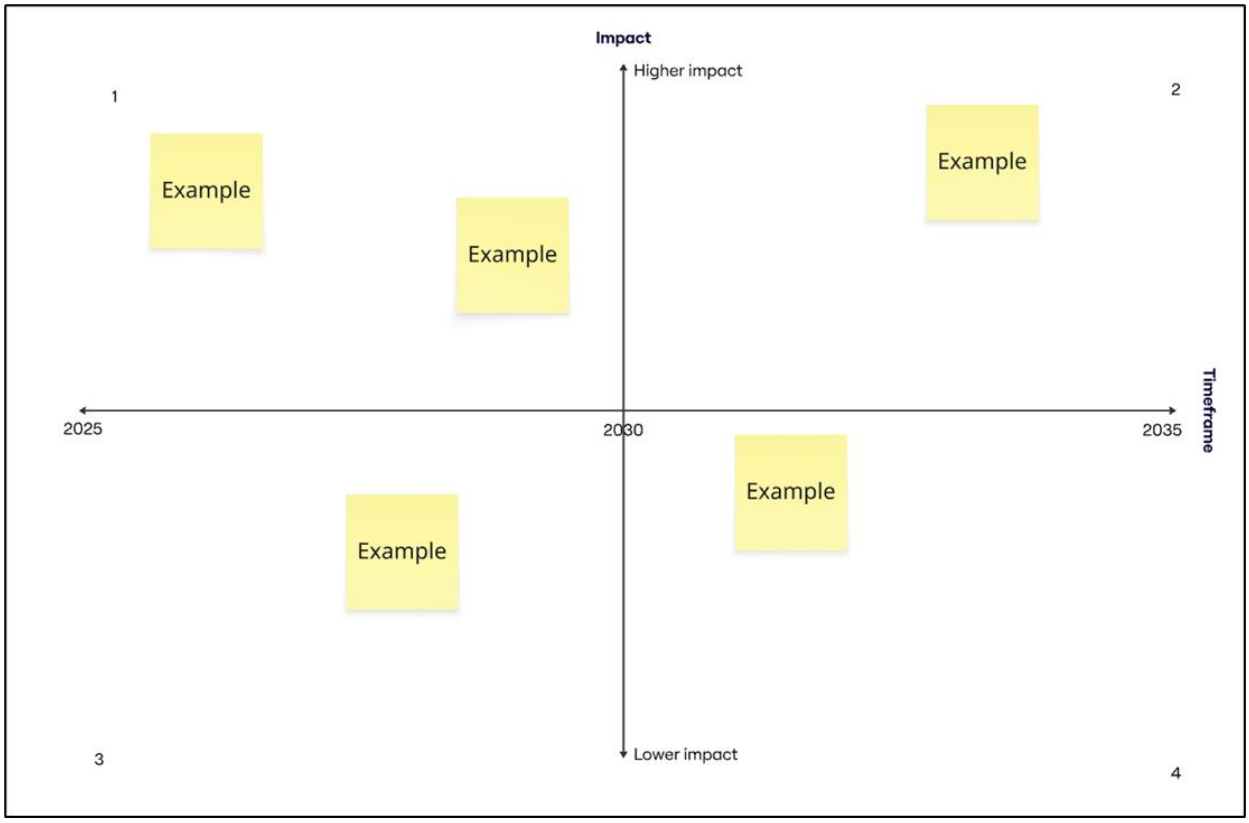

Figure 5: Action prioritisation axes used during Workshop 2 with example post-its

A.3.4 Stakeholder interviews

This section contains a suite of interview questions used during stakeholder engagement, grouped by thematic area to align with the structure of the analysis. Interviews were conducted in a flexible, conversational style, so the questions listed below served as a guide rather than a rigid script.

Table 7: Example questions from stakeholder interviews

Theme	Example Questions Asked
Industrial Decarbonisation & Fuel Switching	• What are the main challenges to producing hydrogen for industrial use in Wales? • What are the barriers to growing the hydrogen economy and decarbonising industry in Wales? What's one key thing that could unlock progress? • What are the risks of not supporting existing hydrogen producers to capture and store carbon (CCS)? How could this affect the wider market? • How can we boost hydrogen production for industrial use across Wales (north and south)? What are the backup options if HyNet is delayed or doesn't go ahead?
Supply & Demand	• What are the main concerns you are hearing from potential offtakers?

	• How could UK or Welsh Government help stimulate demand and offtake for hydrogen? • What actions could help grow hydrogen demand in Wales? • What needs to be done to stimulate sufficient production for industrial decarbonisation in Wales? • Have you identified an increase in demand for low carbon products? • What are the main commercial / financial challenges with regards to the adoption of hydrogen? • Do you find the business models are well-communicated and interpretable? • What are your thoughts on HAR1 and HAR2? What do you want to see from HAR3?
Business Models	• Have you found there to be enough commercial support through the HAR process? • What should UK Government's market engagement for HAR3 include and what issues should it look to address? • How have you found the structure of 'take-or-pay' agreements? • What would you like to see from the Transport & Storage network and Business Models? • What are the main concerns you are hearing from potential investors?
Funding & Investment	• Beyond the industrial clusters we have seen LIDP funding for North East Wales and a plan published. Is this sufficient or is more/something else needed to help industry in Wales decarbonise?
Planning & Regulation	• Are there any specific regulations that you have identified as limiting to increasing the use of hydrogen in Wales?
Power Market Structures	• How is the current power market structures (e.g. CfDs, PPAs) affecting your ability to secure affordable electricity for production?
International competitiveness	• Stakeholders have raised concerns about cost competitiveness. How can Welsh policy respond to this? • How can Welsh Government support industry through fuel switching, especially given the issues of cost competitiveness already identified?
R&D	• What kind of research projects are needed? Is IDRIC enough, or do we need more?

Ambition	• How would you describe the clarity and communication of the hydrogen ambition in Wales? Is anything missing (e.g. like Scotland's Hydrogen Action Plan)? • Do you see the public sector playing a role in the early hydrogen economy, i.e. acting as an offtaker? • What should Welsh Government advocacy look like? • What role should Welsh Government play compared to UK Government, especially since UK leads on business models?